FEBRUARY 1960

ADHESIVES AGE

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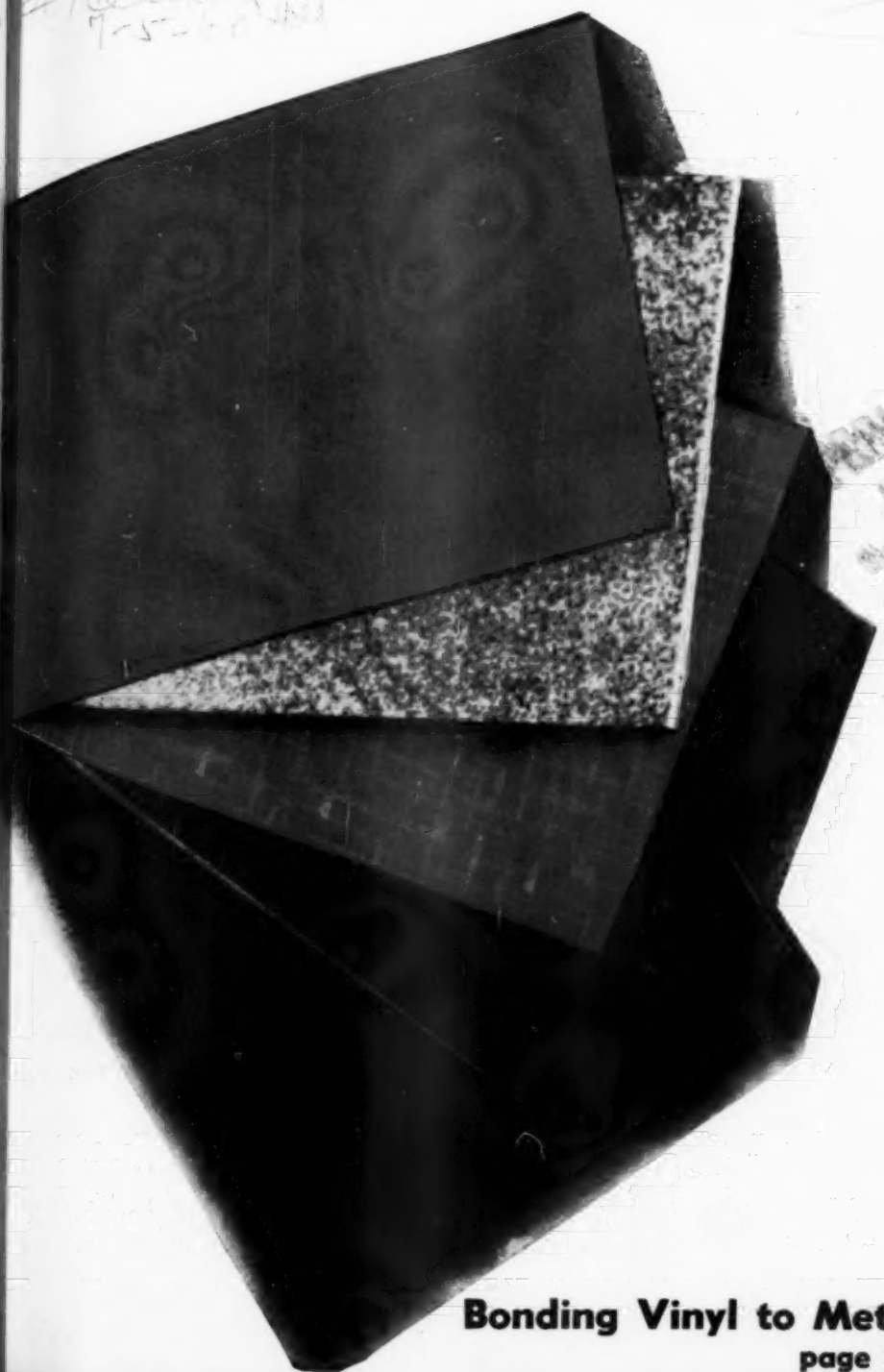

Bonding Vinyl to Metal
page 22

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ADHESIVES AGE

In This Issue

Bonding Vinyl to Metal
New adhesives and techniques provide laminates that may be stamped, punched, deep drawn, bent or crimped into most of the forms that metal normally takes 22

Pressure-Feed Application Equipment—
By Kirk Lightbourne
A sales representative offers some informal pointers on how and when pressure-feed equipment can be used to revamp production lines for greater efficiency and economy 25

Adhesive-Treated Cotton Fabric
Though it looks like heavy gray blotting paper, a ten-second dip in an activator solution will turn this adhesive innovation into a bonding material suitable for long-time repair work 28

New Concepts in Bone Glue Manufacture—
By F. G. Shaw, Jr., and L. B. Lane
Two experts in the field outline modern processing techniques and point out how recent innovations are winning wider acceptance for this important adhesive 30

Bonded Non-Woven Fabrics
Important new data worked up by research laboratories show that a number of gelling agents can be used to control delamination when the fabrics are used in conjunction with adhesives 32

About the Cover Design

This month's cover offers some indication of the wide variety of attractive surface patterns available to the user of vinyl-metal laminates. The article beginning on page 22 outlines recent adhesive techniques that have contributed to the success of this new manufacturing material.

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PALMERTON PUBLISHING CO., INC.

FEBRUARY, 1960

VOL. 3 NO. 2

Gluing-Up Veneer Cores
Preliminary surfacing of wood to be adhesive-bonded is important because in its efforts to strike a balance with the surrounding atmosphere wood may change its form 33

Cutting Production Costs With Bonded Metal Containers
The adaptation of adhesive techniques to the Modular Packaging System provides easily assembled, water-tight, light-weight shipping containers for an electronics manufacturer 35

Rubber-to-Metal Adhesion—
By G. B. Painter
A new method for evaluating rubber-to-metal bonds provides valuable additional information for the researcher 36

Simplified Trailer Top Repair
A do-it-yourself technique using rubber-based cement and a fiber glass membrane makes it possible to repair roof leaks 39

Adhesive Bonding Reinforced Plastics—
By Richard H. Wagner
A detailed survey of the processes involved in bonding reinforced plastics to themselves and to other materials 40

In Future Issues

Bonding Materials Through the Use of Ionizing Radiation
How consumers and suppliers of adhesives can reap the benefits of ionizing radiation

Case and Cabinet Gluing
Techniques and equipment which are available to help the cabinet maker meet gluing problems due to variation in product design

DEPARTMENTS

Book Reviews	62	Names in the News	56
Capitol Clues	14	New Adhesives	10
Classified Advertisements	65	New Equipment	60
Coming Events	54	News of the Industry	45
Consultant's Corner	8	Noted in Passing	66
Editorial	7	On the Continent	18
Patent Review	58		

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BONDMASTER P566: Suitable for thin vinyl surgical bandages and tapes.

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EDITORIAL

A Guest Editorial

Interpretation Of Adhesive Test Results

With the increasing development of new adhesive resins and their wider acceptance in commercial applications, there appears to be a growing need for consumer education in the significance of adhesive strength tests. Excellent test methods have been instituted under the auspices of ASTM and various government agencies, methods which are regularly followed by organizations with serious interests in developing industrial adhesives. Interpretation of test results by the ultimate consumer does not always show comprehension of the problems involved, or in some instances negligence on the part of the adhesive manufacturer in supplying complete data.

Let us examine two adhesive materials, type A, which may be reported as having a lap sheer strength of aluminum to aluminum of 2,500 psi, and type B, which may be reported to have a lap shear strength of 3,500 psi. It is unfortunate, but true, that some design engineers may select a material on the basis of these reported results and specify type B. Such a cursory examination is unfortunate, because there are so many other factors involved. In fact, the lower shear strength may be indicative of the more resilient character of the adhesive and the probability of greater peel strength.

Let us assume that lap shear and peel strength are adequately reported. One should examine further the many environmental influences and their effect on bond strength. These data are somewhat sketchy for the newer adhesives. In lieu of this, trial and error may prevail, although in the hands of unskilled people, the results are often questionable. Furthermore, adhesive test data should be reported, for proper interpretation, showing the influence of manufacturing variables. If two components are present, what happens if there is a variation in the proportion of curing agent? What occurs if the manufacturer's recommmendations for cure are not precisely followed?

More complete analyses are not only necessary for commercial applications. Practically speaking, if the data is not completely available, let us acquaint design engineers with some of these parameters, so that we can enjoy their confidence to a greater degree.

John Delmonte
General Manager
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CONSULTANT'S CORNER

By Dr. Irving Skeist

Question: We have been using a cured epoxy adhesive in rather large quantities and have had quite a bit of trouble as those who handle it tend to develop skin rashes. Creams and gloves are used, but we believe that the solvent used for clean up is the trouble. It is a 1:1 mixture of toloul: isoproponal. Can this cause skin trouble? It was recommended as one solvent that would work well for hardener or resin alone or for both mixed, and is not too expensive. If we are having trouble with this solvent, can you suggest another which will do a good clean-up job and not cause trouble?

Answer: Toluol is toxic and may be causing the dermatitis. The isopropyl alcohol, of course, is harmless.

Two other solvents should be tried, either alone or in mixtures with isopropyl alcohol: ethyl acetate and methylethyl ketone (MEK). Ethyl acetate is innocuous and fragrant. MEK is a more effective clean-up liquid, but may be irritating to some people.

Q-136

Question: We are manufacturers of spectacle cases and have a bonding problem that has plagued us for a long time. We would like to laminate a piece of unsupported polyvinyl chloride to a piece of rubber impregnated flannel that has had a flocking put on one side. A water-soluble adhesive would be preferable since it is much easier and more pleasant to work with.

Answer: A waterbase adhesive can be formulated from nitrile rubber latex to provide moderately good bonding of polyvinyl chloride to rubber. Since both adherends are impervious, the water should be evaporated completely before the surfaces are mated. The nitrile rubber latex adhesive will function best if the impregnating rubber is also of the nitrile (butadiene/acrylonitrile) type.

Q-138

Readers who would like to contribute their own experience with problems similar to those discussed in Dr. Skeist's column are invited to write to ADHESIVES AGE, *101 West 31st Street, New York 1, New York. Please refer to the code number given at the end of each question and answer group.*

CONSULTANT'S CORNER

Question: Can you recommend an adhesive which will bond asbestos board to steel? The asbestos board has a cement binder with a pH of about 14.

Answer: A neoprene/phenolic contact cement may be suitable. The cement is applied to both adherends, the solvent evaporated, and the tacky surfaces brought together. Heat is applied to cure the rubber and complete the cure of the phenol-formaldehyde resin.

An acid acceptor such as zinc oxide is often incorporated in neoprene adhesives to take care of the hydrochloric acid liberated as the rubber ages. Despite the high alkalinity of the cement binder for the asbestos board, it would be prudent to have the acid acceptor in the glue line for the sake of the steel.

Q-130

Question: In making sandpaper belts, we are now using a glue that requires overnight drying before the belts can be used. Making the belts requires considerable work and if possible we would like to simplify the operation.

We remove the grit from one end of the sandpaper, apply the glue and overlap the other end. The belts are then fastened down to dry and after drying they must be released. Is there a contact cement which would eliminate part of this operation? The drying time of this cement should not be more than 30 minutes. The cement should be resistant to heat.

Answer: Two types of flexible adhesive should be evaluated:

(1) A liquid epoxy resin cured with a flexibilizing amine, polyamide or polysulfide hardener.

(2) A neoprene or other rubber cement in organic solvents.

Q-139

Dr. D. S. Threlkeld, research director of Clopay Corp., Cincinnati, Ohio, suggest another solution to the problem of laminating vinyl to wood which was discussed in this column in the October 1959, issue.

For years, he writes, his company has supplied vinyl films cast onto paper substrates. Many manufacturers have used these materials in the production of luggage and similar items, pasting the cast film to both wood and chip board surfaces. The materials have proved excellent for these applications, he reports.

Dr. Threlkeld also points out that manufacturers sometimes use adhesives that are cheaper than those normally required for laminating vinyl film. By using cast films, however, they do not have to contend with problems of migration or solvent trap.

Dr. Skeist is associated with Skeist & Schwarz Laboratories, Inc., 89 Lincoln Park, Newark 2, N.J. He is the author of the recently published book, "Epoxy Resins."

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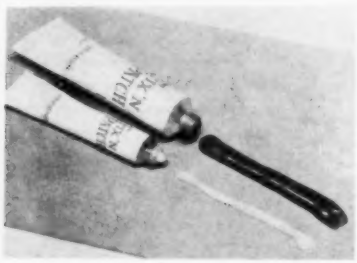
new adhesives

AND ADHESIVE PRODUCTS

Two-Part Epoxy Adhesive

A two-part epoxy adhesive, called Fix'n Patch, and used in aircraft, automotive and missile construction, is now available. Packaged in two self-measuring tubes, Fix'n Patch is said to be easy and economical to use. Proper mixing proportions are obtained by dispensing equal length



beads of material from each tube, using only as much Fix'n Patch as the repair job requires. Designed for permanent repairs to porcelain products, furniture, steel, aluminum, leaky pipes, valves, tanks and radiators, Fix'n Patch is waterproof, gasoline proof, non-flammable and highly resistant to chemical attack. Off-white in color, it can be painted, drilled and sanded and will bond to metal, glass, wood, rubber, ceramics, plastic and fabric. *Specialty Plastics Co.* P-249

Epoxy Laminating Systems

Two improved non-irritant epoxy laminating systems, Maraset laminating resin No. 607-AA and brilliant white gel coat No. 606, with safety hardeners specifically formulated for each resin, were developed to reduce or eliminate allergenic reactions which sometimes occur in susceptible individuals. The catalysts are non-fuming, relatively odorless, and so compatible with the resins that they can be readily mixed into a thorough blend that avoids trapping of air bubbles. Their non-hygroscopic character allows them to set up even under humid conditions, for a room-temperature cure rapidly providing tack-free surfaces. Resin No. 607-AA has wetting characteristics that adapt it to combining glass fibers for sturdy reinforced plastic tools and parts. Properties are said to include low shrinkage, dimensional stability, good chemical resistance, 36,900 psi flexural strength, 31,700 psi tensile strength, and 27,600 psi compressive strength, with Rockwell M hardness of 85. The hiding properties of Resin No. 606 make it useful as a surface coating for molds or models where glass fiber pattern or texture should not show through. Both resin systems have a pot life of 15 to 20 minutes. *Marblette Corp.* P-250

Cure-Set Adhesive

A new non-flammable waterproof adhesive for bonding rubber and vinyl tile to on-grade concrete, linoleum to steel, terrazzo, ceramic tile and other non-porous surfaces has been developed. Called Cure-Set, the adhesive material is also recommended for bonding metal stair nosings, trim, trackless carpet strips and other floor accessories. According to the company, tiles may be set within 10 minutes after spreading the adhesive with a notched steel trowel. The product is a two-component system for cold applications. It has a working life of about 30 minutes and a full setting time of 24 hours. Available in both liquid paste and powder form in one-gallon sizes, Cure-Set is ready to use and features long storage life. *Borden Chemical Co.* P-251

Rubber Paste

Developed for permanent repair work, Devcon Rubber is a real rubber in paste form. It is applied directly from the squeeze-type tube and dries and sets within a few hours into long-lasting, pliant, elastic rubber. It is designed for caulking, insulating, sealing and waterproofing applications. It bonds to rubber, metal, wood, glass, plastics, porcelain and fabrics. The manufacturer points out that during two years of pre-testing it was found to have extremely high tensile strength and excellent resistance to weather and sunlight as well as oil, water and chemicals. *Devcon Corp.* P-252

Cohesive Plastic Tape

A chemically inert plastic tape designed to seal and to permanently lubricate threaded and coupled pipe joints, Scotchrap brand Dry Thread Sealer No. 4212 is an unfused film tape which can be applied in seconds and conforms to all types of pipe threads and fittings in any pipe system. Made with a Teflon TFE-fluorocarbon resin, the tape is said to

withstand processing temperatures from the liquid-oxygen range through that of super-heated steam. It is not affected by oil traces or other lubricants in the steam line. Although non-adhesive, the tape is sufficiently cohesive to stick to its own glossy surface, as well as any pipe thread.

Dry Thread Sealer No. 4212 is reported to eliminate the need for brushing messy dope solutions on pipe fittings. It can be applied by one person; a single wrap in a clockwise direction around joint threads provides a permanently lubricated, leak-proof, freeze-proof joint that never dries out. Excess tape can be torn off. Due to the anti-sticking characteristics of the tape, joints can be loosened and detached years after the threads are taped. Applications include gas meter hook-up, oil casings, oil rigs and refineries, chemical plants, conduits, couplings, valve sealing, high pressure systems and chemical lines. The white, pliable ½-inch wide tape is available in 260 or 520-inch lengths. *Irvington Division, Minnesota Mining and Manufacturing Co.* P-253

Automatic Spray Adhesive

Many porous and non-porous surfaces can be bonded with EC-1390, an oil-resistant elastomeric base adhesive developed for automatic spray application in volume production operations. Bonds produced with this high-strength adhesive are said to have high softening points and excellent resistance to plastic flow. It

Piccopale emulsions

the perfect mixer. Piccopale emulsions fortify and improve the important properties of latices, resin emulsions and other water-based systems. Available in a variety of grades, these emulsions are broadly compatible, water and alkali resistant, provide excellent adhesion and pigment binding, are low in cost and available in abundant supply.

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is recommended for the production of laminates with materials such as plastic, thin gage aluminum and steel, porcelain enameled steel, linoleum, leather, rubber, wood, composition board, etc. In application, the surfaces to be bonded are first cleaned and sufficient adhesive is sprayed on to insure a dry film of 2 to 3 mils on each surface. Films are dried at 200°F. and immediately bonded under a pressure of 100 psi. *Adhesives, Coatings and Sealers Division, Minnesota Mining & Mfg. Co.* P-254

Non-Metallic Adhesive

Bond-Seal is a plastic adhesive which adheres to most metals but has a non-metallic base. It can be used for making water-tight and oil-tight repairs where non-conductivity and resistance to acids and alkalies is needed. Specifically developed for use in electronic applications where adhesives containing metallic fillers are not acceptable, Bond-Seal is said to have high adhesion to iron, steel, aluminum, wood, glass, concrete, epoxy and polyester laminates. With steel, it has tested up to 3000 pounds in tensile shear. It will not adhere to plastics like vinyl, polyethylene or polystyrene. *Beetle Plastics, Crompton & Knowles.* P-255

Teflon Film Tape

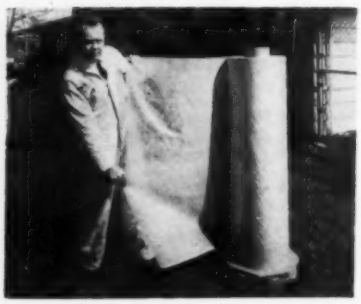
Anti-stick, self-lubricating, temperature and corrosion resistant properties of 423 Teflon Film Tape, a two mil Teflon film with a pressure-sensitive adhesive, has a variety of uses in the chemical field where non-corrosion is important. It is also used in packaging applications as an anti-friction lining on heat sealing machinery, conveyor belts, chutes, etc. The tape is readily printable with ordinary printing inks. An interliner is provided to facilitate die-cutting the tape into any desired shape. *Permacel.* P-256

Foam Tape

Foamade Foam Tape can be used to weatherproof, seal, insulate, cushion, and dampen vibration. The polyurethane tape is self-adhesive. Both water resistant and flame proof, the tape is said to withstand outdoor aging and is not affected by temperature, humidity, oils and most chemicals. It can be ordered in colors and in any length or width. *Foamade Industries.* P-257

Dry Phenolic Resin

Many of the disadvantages of earlier film-supported adhesives are said to be overcome with Plyophen 2000-PGL, a dry phenolic resin supported by a paper film. The dry adhesive eliminates the need for spreading equipment. A sheet of Plyophen



is placed between the two surfaces to be joined and the bond is cured either in a hot press or by means of high frequency field heating. Layups may be stored for considerable periods at normal temperature and humidity before pressing. The paper glue line is said to eliminate bleed-through and provide control of adhesive flow. It is currently available in widths of 38, 50 and 62 inches. *Reichhold Chemicals, Inc.* P-258

Adhesive Paint Sheets

Pre-dried self-adhesive sheets of pure paint now make it possible to paint without brush or bucket. The sheets of paint are sealed between two layers of paper, one protecting the adhesive and the other covering the paint surface. In application, the sheet of pre-dried paint is cut to fit the surface area, the backing stripped off the adhesive side, and the paint firmly positioned on the surface to be covered before the surface layer of paper is removed. Manufacturers' tests indicate that the fluorescent colors resist fading for upwards of two years under outdoor conditions. *Morgan Adhesives Co.* P-259

Plastic Putty

Narmco 3150, a thixotropic plastic putty, cures at room temperature into a solid chunk of epoxy resin. The putty is designed to trim the edges of lightweight sandwich structures, providing a rigid, structurally strong edge for fastening the sandwich. No special molds or jigs are required for casting the putty. Since it has a thick, putty-like texture, it may be spatulaed directly into place with a putty knife, or spread with a standard caulking gun. The resin locks into the exposed edge of the honeycomb, completely filling the open gap between the two sandwich skins. Narmco 3150 is a two-part system, consisting of a resin and a liquid catalyst, or hardener. The two are mixed and applied immediately, and within 15 minutes the putty will begin to harden. *Narmco Resins & Coatings Co.* P-260

Grit-Impregnated Resin

M-S-A Dura-Grip surfacing compound is a durable anti-slip material composed of a resin bonding agent impregnated with high quality grit. Its application is like that of paint; a brush or roller may be used and no special skill is required. Surfaces to be coated must be thoroughly clean and dry. A small area is coated and the abrasive sprinkled on while the compound is still wet. After an hour of drying time at room temperature, the excess grit can be swept off and reclaimed. A second coat of the bonding mix is then rolled on over the grit. In average warm temperature, a treated surface is sufficiently cured for light traffic in six hours, and for heavy traffic in 16 hours. *Mine Safety Appliances Co.* P-261

Chemotec Adhesives

Two epoxy based series of bonding agents are the Chemotec 700 series, thermosetting adhesives, and the Chemotec 800 series, which are cold setting. Available in powder, paste, rod or liquid form, the Chemotec 700 series, show tensile strength in excess of 5,000 psi, resistance to weather, galvanic action and most chemicals, acids and alkalis. They are used to bond metal to metal, metal to glass, graphite, asbestos, ceramics at low heat without pressure. The Chemotec 800 series are available in paste and liquid form. These bond at room temperature after a period ranging from 24 to 72 hours. Having a wide variety of applications, they also exhibit resistance to weather, galvanic action and most chemicals, acids and alkalis. *Polymer Industries, Inc.* P-262

FOR MORE INFORMATION on the new equipment items described here, use the Reader's Service Card elsewhere in this issue.

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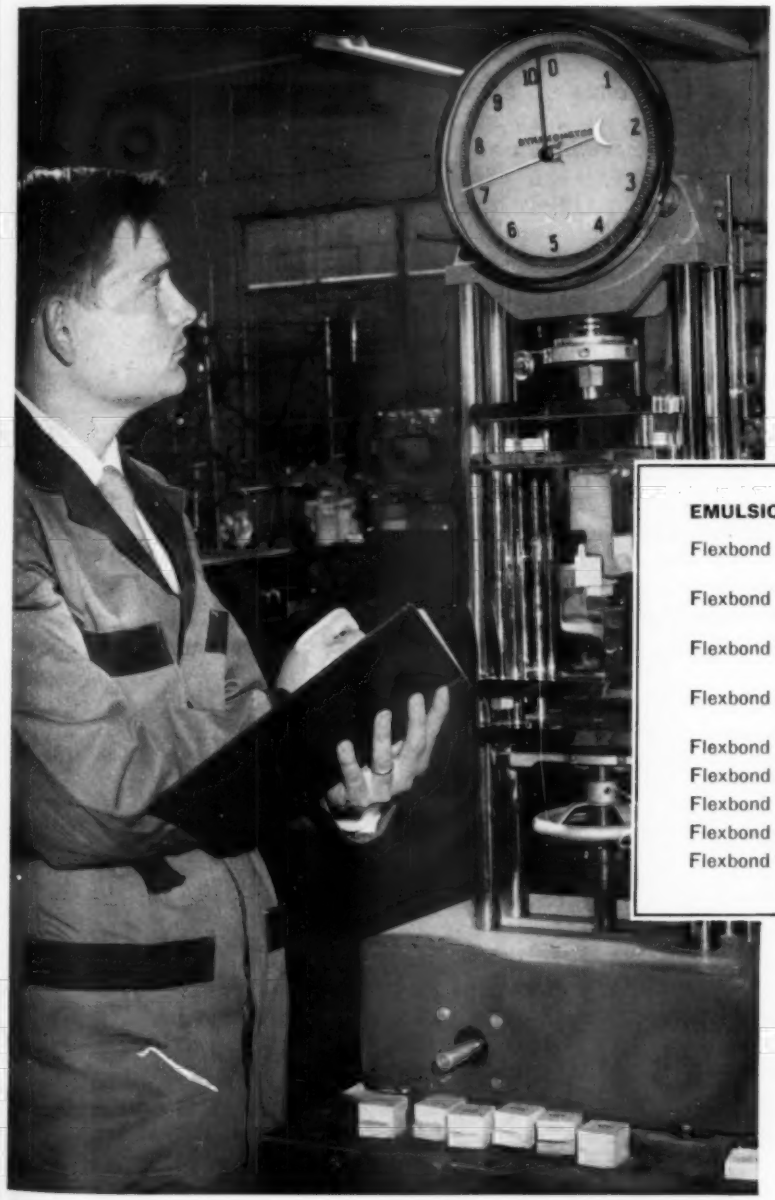
with improved adhesive properties permanently built into the polymer chain



As adherends increase in variety and complexity the adhesives industry is constantly facing new, special problems. Now Colton offers formulators a welcome problem-solver: Flexbond copolymer emulsions. This versatile group assures better results than conventional emulsions because the units needed for special adhesion are permanently incorporated into the polymer chain. Flexbond copolymer emulsions supply flexible, water-resistant bonds.

With Flexbond copolymers even specialized fields of packaging and film lamination can utilize the advantages of acetate emulsions. And many plastic materials previously considered difficult to join now show enhanced adhesion with copolymer emulsions.

The wide range of grades of Flexbond copolymers now available is suggested by the following table:

EMULSION	DESCRIPTION
Flexbond 800	Vinyl acetate—dibutyl maleate copolymer
Flexbond 803	Vinyl acetate—dibutyl maleate copolymer
Flexbond 802	Vinyl acetate—dibutyl maleate copolymer
Flexbond 855	Vinyl acetate—dibutyl maleate terpolymer
Flexbond 306	Vinyl—acrylic terpolymer
Flexbond 100	Vinyl acetate—stearate copolymer
Flexbond 126	Vinyl acetate—stearate copolymer
Flexbond 128	Vinyl acetate—stearate copolymer
Flexbond 165	Vinyl acetate—stearate copolymer

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POLITICS AND ECONOMY WILL DOMINATE CONGRESS in the year that is just getting under way. It will be a short and hectic session, producing very little in the way of legislation of importance to businessmen. Next Fall's elections will be occupying the mind of virtually every lawmaker. Members of both parties will want to wind up work in a hurry to start campaigning.

Every major issue that does come up faces two important tests:
- First, will it be popular? Will it attract votes for members who back the bill? The Congressmen will want to know if it will help them win re-election and with the White House race.
- Second, will it be costly? Neither the Republicans nor their opposition want to be blamed for upsetting a balanced Budget.

These pressures make it hard for party leaders to find catchy issues. Too often, vote-getting programs are very expensive.

This dilemma will be toughest on the Democrats. They already are walking a precarious tight-rope, trying to be "the party of the people" without being tagged by the GOP as spenders.

THE DEMOCRATS WILL BE FORCED TO RELY ON TWO KEY THEMES as this session goes along. Foreign policy is one. In this field, they will challenge the Administration on Ike's approach to Russia; they will also criticize the GOP for missile lags and push for more aid to underdeveloped countries. And on a second front—domestic policy—Democrats will campaign against tight money and charge that today's credit policies hurt the economy and small business. The Democrats also will make much of programs to help consumers and farmers.

POLITICS WILL SHOW UP IN VOTES ON THE NEW BUDGET—the one that is being submitted for the 1961 fiscal year, which begins next July 1. The Budget will end up balanced—that much is sure. It will even show a respectable surplus. A group of liberal Democrats will still press for expensive programs in the field of education, social security, aid to depressed areas, etc. But Ike's vetoes and the "fiscal responsibility" of Democratic leaders will block them.

In the end, the President's Budget may end up $1 billion or so higher than he asks. But part of the hike will reflect things beyond any control—higher farm payments, higher interest rates on the national debt, etc. Tax revenues may well be somewhat higher than estimated, which would still leave a tidy surplus.

LABOR LEGISLATION MAY AGAIN BE A BIG CONCERN of Congress, particularly if a national rail strike adds to the damage done by the steel walkout. The legislators had felt that, with the passage of last year's sweeping law, they would be through with labor-management problems for some time to come. They won't want to do anything on labor on an election year—that's clear. But the President feels that the economy can't be subjected to another strike such as it took last Fall—a buffeting that cost billions of dollars in lost output. So, depending on developments, Congress may be forced to vote new labor laws.

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THE PRESIDENT WANTS TO HOLD SPENDING TO $80 BILLION during the next fiscal year. By the time Congress gets through, though, the figure may be up to around $81.5 billion. As for revenue, the President hopes for something in the neighborhood of $83 billion. But good business could lift income as high as $85 billion. So, the surplus will run at least $2 billion and could go up to $3 billion. In the current fiscal year, spending will come out to around $78.9 billion, with total tax revenues only about $200 million less.

Here's how the money will be spent in the coming fiscal year:

- For defense, the Budget will attempt to match this year's $41 billion—more for missiles and space and less for planes.
- For foreign aid, Ike wants $4 billion in new money, but sharp cuts will be made. Backlogs of unspent money, though, will keep spending high. Military assistance will be emphasized.
- For agriculture, Ike wants to keep outlays under the figure for this year. But good crop weather would upset this hope.

New programs and some recently started will account for hikes in the Budget. These include air traffic controls, pensions for war widows, new health insurance for U. S. workers, etc.

There aren't any big decreases in federal programs in the new Budget. And Congress won't go for some revenue saving plans—higher postal rates, loading some jobs on the states, etc.

CHANCES OF A TAX CUT FOR INDIVIDUALS ARE NOT BRIGHT for this session, although Congress will make some important revisions and adjustments in law. Generally good business has killed one of the greatest arguments for cutting rates. And Eisenhower would rather use the surplus to cut the federal debt.

Here's how Congress probably will deal with specific tax bills:

- The Keogh bill, to give the self-employed deductions for funds placed in their own pension plans, has a fair chance. It has already passed the House and is now in the Senate. Treasury opposition is the big hurdle. Eisenhower may sign it, anyway.
- Corporate taxes will be continued for another year at the 52% rate. Excises also will be extended at the high Korean rate.
- Depletion allowances will get a lot of attention. There'll be efforts to cut the rate but nothing is expected in 1960.
- Patronage dividends of co-ops may be taxed—to the patrons.
- Union and trade group dues will be an issue, prompted by the efforts of Internal Revenue to deny exemption when the funds are used for lobbying. Congress will block the IRS campaign.

THERE WILL BE BIG DRIVES TO SPUR HOME-BUILDING during the 1960 session. Some Congressmen already are concerned about shrinking prospects for housing, and others will join as time goes on and mortgage money gets tighter. There will be a strong Democratic push for a new $500 million program to finance government purchases of mortgages on low-cost homes. Such a program would get 500,000 units built. Ike will oppose the plan; the final vote will be close.

The democrats want to expand the college-housing loan program. Ike, instead, wants government guarantees for private lenders, but he may go along with the Democrats. Other programs, for slum clearance and housing for the aged, etc., won't get far.

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- Fabric to Plastics
- Fabric to Rubber
- Fabric to Wood
- Formica to Plywood
- Glass to Decorative Plastic
- Glass to Ceramics
- Glass to Fabric
- Glass to Formica
- Glass to Glass
- Glass to Metal
- Glass to Paper
- Glass to Plastics
- Glass to Rubber
- Glass to Wood
- Leather to Leather
- Leather to Metal
- Leather to Rubber
- Metal to Ceramics
- Metal to Metal
- Metal to Plastics
- Metal to Rubber
- Metal to Wood
- Neoprene to Neoprene
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- Rubber to Ceramics

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• The viscosity of cast high polymers is being determined in France by means of ultrasonic equipment. The apparatus used is of the high viscosity type, having a sonde consisting of a bar of magnetostrictive steel separated into two parts by a diaphragm. Half is in the interior of the body of the sonde in a bobbin insulated by a ceramic material while the other half is designed to be immersed in fluid to measure its viscosity. The apparatus can serve in the study of cast high polymers to establish comparisons between the different varieties of the same product or when the evolution of a phenomenon is to be followed.

• *The Catalog of Technical Reports,* published by the U. S. Departmentof Commerce, Office of Technical Services, lists many valuable pamphlets, books and special technical reports. One section of these reports has been combined in a special edition which deals only with adhesives. Among the many titles listed are the following:

Adhesives Handbook. Part 1. Engineering Principles. Presents some aspects of the physical and engineering principles as presently understood, for the design, assembly and inspection of adhesive bonds and for the testing of adhesives.

Adhesives Handbook. Part II. Engineering Data. A compendium of typical data and information on proprietary adhesives such as those found in various specifications, manufacturer's literature, periodicals and reports by commercial and government laboratories. Specific applications involving adhesive-adherend systems are presented.

Effect of Synthetic Resin Adhesives on the Strength and Physical Properties of Wood Veneer Laminates. This pamphlet has been published by the School of Forestry of Yale University, 205 Prospect St., New Haven 11, Conn., and must be ordered from this source.

Improved Cellulose Caprate Optical Cement. The cellulose caprate is given special extraction, decolorization and filtration processes before plasticizing to yield a nearly ideal optical cement. Tests and results indicate that this cement can eliminate the use of balsam for surface-borne optical instruments.

The Setting Process of Wood Gluing. Chemicophysical aspects of the bonding process in wooden constructions are discussed. A description is given of bonding methods for conventional glues (gelatine, casein and phenoplastics), softening agents, application to wood, use of pressure and heat, and hardening characteristics. Static stress test methods for bonded structures are also discussed.

The publications listed above may be ordered from the U. S. Department of Commerce, Washington 25, D. C.

• The British Glue and Gelatine Research Association has begun a campaign publicizing advantages of animal glues. The campaign is said to have been triggered by the inroads made by synthetic glues or adhesives. A few paragraphs taken from an editorial published in *The Financial Times* in London, show the extent of the British efforts to promote the use of animal glues. Comparing the virtues of synthetic and animal glues the Association points out that animal glues differ from synthetic glues in their gelling properties which have a particular value with gluing. "The spread glue film rapidly becomes very tacky and quick set is obtained due to gelation before the joint has had time to dry completely. Joints need therefore remain in clamps for a comparatively short time and in some instances (rub joints) good joints can be made without clamping. The same properties of rapid tack and set make animal glue valuable for sticking paper and fabrics to wood and cardboard. This advantage of animal glue entails the disadvantage that glue solutions must be kept hot while in use. Where this is inconvenient, fish glues and liquid animal glues may be suitable.

"Animal glues are normally used as a solution at a concentration of 40-55 per cent, depending on the grade. Except when sold as liquid or jelly glue, the glue is prepared by allowing the dry powder to swell in cold water and then warming in a jacketed vessel until dissolved. The concentration and grade of the glue should be such that the glue can be applied satisfactorily, and becomes tacky, while not yet setting to a gel, when the parts are ready for assembly. The best results are obtained when the surfaces to be joined are as smooth and as flat as possible so that the glue line is as thin as possible.

"The use of adhesives and the range of adhesives available have been greatly extended in recent years, and in many instances the traditional animal glues have been replaced by synthetic glues. Animal glues, however, owing to their unique properties and adaptability still constitute one of the most valuable classes of adhesive."

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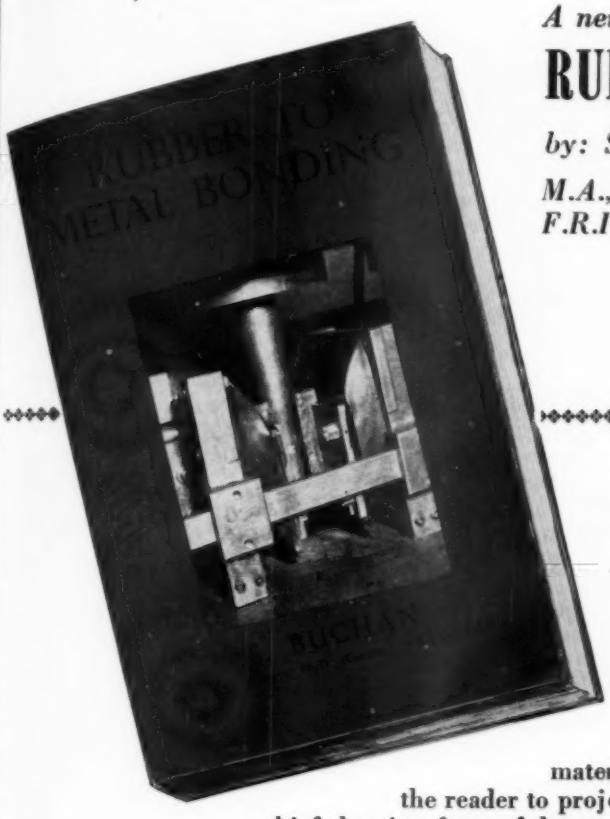

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CONTENTS:

Introduction
Plating Plant
Cleaning Solutions
Brass-Plating Solutions
Methods of Analyses
Electro-Plating
Processing and Process Control
Natural Rubber Compounding
Synthetic Rubber Compounding
Molds and Molding (38)
Physical Examination of Brass Deposits
Chemical Examination of the Rubber-to-Brass Bond
Properties of the Rubber-to-Brass Bond
Bonding Agents, Thermoplastic
Bonding Agents, Halogenated Rubber Derivatives
Bonding Agents, Polyisocyanates
Bonding Agents, Various
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On the Continent (cont'd)

• National Distillers and Chemical Corp. has formed a wholly-owned subsidiary in Switzerland to stimulate and expand sales of polyethylene in world markets. The subsidiary will be known for trade purposes as U. S. I—International. The firm will market polyethylene made in the United States, partly from warehouses located abroad. Offices and technical service laboratory facilities will be constructed at Baar, Canton of Zug, Switzerland.

• When the China Plastics Co. was organized in Hong Kong, the plastics industry began to grow in that territory. By the end of 1958 there were 296 factories manufacturing all types of plastic goods. The leading factory, Kader Industrial Co., employs 700 workers. All told there are about 8,000 people employed in Hong Kong plastic industries. With few exceptions, those factories are owned by Chinese people. Raw materials are imported and almost all of the machines used are based on foreign design. Among the wide range of products manufactured in Hong Kong, toys are featured by 156 enterprises which more or less specialize in this line. Particularly successful are eleven manufacturers of artificial flowers.

Although production of this merchandise was begun as recently as 1957, Hong Kong was able to wrestle the leading role in the world market from the Italians. In 1958, artificial flowers valued at about $2 million were exported, with 99 per cent of this total shipped to the United States. Recently, an association of plastic manufacturers was organized to avoid overexpansion of the plastic industry and to increase the quality of the manufactured merchandise.

• Austrian Production of Plastic Raw Materials and plastic merchandise has tripled during the last four years. In 1954, only 10,000 tons were produced while 14,600 tons were produced in 1955 and in 1958, 29,750 tons were manufactured, much of which was exported to the adjacent countries. Having obtained licenses of American patents, small containers made of polyethylene, particularly tubes and bottles, will henceforth be manufactured in Austria.

• Yugoslavia will double its capacity for plastics products. The only Yogoslavian plastics factory which is located near Kastel Sucurac in the vicinity of Split, will double its capacity and enlarge the range of products manufactured there. At the outset, only 3,000 tons of PVC-powder and 2,000 tons of semi-finished products were produced. Production of PVC-powder has now been increased to 5,000 tons and will be increased to 7,000 tons before long. At the same time production of finished goods will be increased to 6,000 tons. The range of products comprises emulsions of PVC, rigid and elastic plastic tubes, plastic wall coverings, laminates for furniture, synthetic leather and others.

• The Department of Commerce of the United States Government is determined to stimulate exports and to decrease the gap in the international trade balance. To diminish the trade deficit of almost $4 billion the government will, in its participation in trade fairs and exhibits abroad, henceforth diminish its emphasis on selling the free enterprise system and do its best to sell goods. Staffs of commercial attaches of the various embassies in the major countries of the world will be enlarged, permanent exhibits of American products will be established overseas and major trade and business organizations will be enlisted in the campaign to acquaint businessmen with foreign trade opportunities.

Studies will be undertaken to determine whether credit terms and facilities for foreign buyers can be liberalized, shipping facilities improved and freight rates reduced. Boosting exports is the best way to offset the imbalance of payments which last year caused a $4 billion outflow of gold and dollars. It is well within the range of possibility to increase our exports by 12 to 20 per cent during 1960.

Industry and trade can cooperate in efforts to stimulate exports. Manufacturers may contact the Department of State to obtain, from the Office of International Trades, a list of all the Commercial Attaches in the various American Embassies. It is also suggested to approach the Department of Commerce, Bureau of Foreign Commerce, to obtain information regarding the possible expansion of exports. Both departments are in Washington 25, D.C.

Using the State Department list, a letter accompanied by a list of goods or materials manufactured and to be exported to the respective countries should be sent to each individual commercial attache asking him to suggest ways and means of entering the particular markets. A similar letter describing the contemplated export efforts should be addressed to the Department of Commerce, which will be able to submit quite a number of useful suggestions.

It is deplorable that American businessmen very seldom engage the assistance and help of the government organizations. Talking to several commercial attaches in European countries during our recent trip, we have been told that American businessmen do not use the services which are readily available and which in many instances are almost invaluable and cannot be replaced by other means of information. Due to the fact that every one of us pays for these elaborate services, we can only encourage every manufacturer to try to make full use of all the facilities which the government puts at his disposal.

American Chambers of Commerce which exist in almost every part of the world can also supply valuable information. They are usually members of the United States Chamber of Commerce located in Washington. A letter to this organization will bring the addresses of the respective Chamber of Commerce located in the particular country.

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STAFF REPORT

Bonding Vinyl to Metal

Perfection of a new adhesive technique for making plastic-clad metal makes a rugged, handsome material available to industry

In recent years, the development of a technique for bonding smooth or embossed vinyl to sheets of steel, aluminum or magnesium has created a "pre-plastic-clad" metal for industry.

Vinyl-metal laminates are not only attractive in the finished product, but simple to work with and extremely rugged. They may be stamped, punched, deep drawn, bent or crimped into most of the forms metal normally takes. If the laminating process has been correctly carried out, they will come through this rough treatment undamaged.

A vinyl protective coating is ten times thicker than conventional metal finishes and won't crack, chip or craze. In addition, vinyl will resist heat (up to 200°F.) light and weather, and has excellent abrasion and corrosion resistance.

As a result, vinyl-clad metals offer an almost limitless variety of decorative effects and are virtually maintenance-free. They are widely used in scores of industrial and construction applications, as well as in the production of various finished products for the consumer.

During the development stages, the vinyl-clad industry was faced with a number of problems which had to be resolved before efficient and economical mass production could start. To begin with, of course, the components of the laminate had to meet certain rigid specifications.

For example, the vinyl used must be of sufficiently high quality to withstand subsequent processing. Improper or too heavy a concentration of plasticizer may cause migration into and attack upon the bond. On the other hand, too little concentration of plasticizer would result in the vinyl having insufficient flexibility to permit the stretching and bending involved in later manfacturing steps.

The success of a vinyl-metal laminate will as often as not depend on the adhesive used to bond the components. Naturally, the finished laminate can only be as strong and serviceable as the adhesive bond. Thus, the development of an adhesive formulation which would meet all the stringent requirements was a vitally important step.

First of all, of course, the adhesive had to have exceptional strength properties in addition to high plasticizer migration resistance. Its peel strength had to be greater than the plastic, so that the vinyl would actually tear when the bond was tested for tensile strength. Another requirement was that the adhesive resist "creep" at elevated temperatures and hold the vinyl in spite of its plastic "memory."

In addition, the formulation had to be one that would lend itself to an easy and efficient application method that fits in with standard production setups.

Evaporating Solvent

Before the metal and vinyl can be joined, all solvent must be evaporated from the adhesive film. This process should take place as rapidly as the production speed requires, but not so fast that it brings about a viscosity increase great enough to interfere with the pace of the coating operation. To govern this, slow-drying or fast-drying solvents or a "custom-blend" of both types can be employed.

Other problems which plague the manufacturers of vinyl-metal laminates are the potential hazards inherent in the heat and pressure required to activate the adhesive film and to mate the two materials. Too much of either or both will damage the vinyl sheeting, too little would create an inadequate bond, and the limits of tolerance are relatively narrow. The formulating problem, therefore, was to develop a product with the proper balance of both variables so as to achieve higher strength bonds at the lowest possible combining temperatures.

In its search for a formulation sufficiently refined to meet all these requirements, one manufacturer worked closely with its adhesive supplier, Rubber & Asbestos Corp., Bloomfield, N.J. As a result of this collaboration, the manufacturer now enjoys a smooth-flowing production line turning out high quality vinyl-metal laminates at the rate of approximately 30 feet per minute.

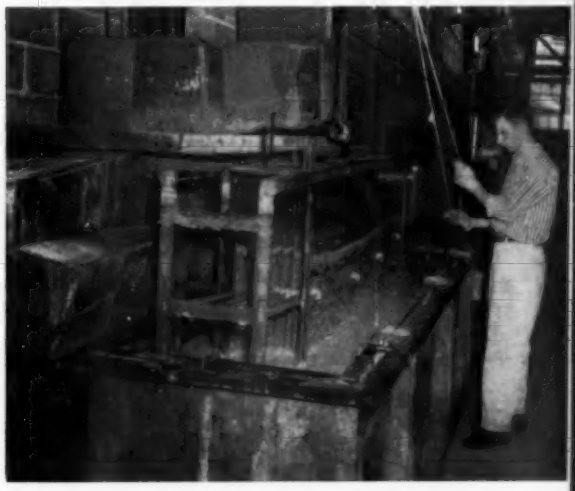
The adhesive developed, Bondmaster Z782, is a clear, synthetic-resin-based formulation that combines the ease of application derived from its extremely low viscosity (450-650 cps) with a relatively high solids content, 30 per cent, that leads to superior "mileage." The comparatively lower heat required for adhesive reactivation makes it possible to preserve patterns when embossed vinyl is used and prevents the adhesive from turning "brown" when exposed to elevated temperatures.

Experience showed the firm that although the four basic stages—cleaning, coating, curing and mating—of the laminating process itself are not complex, they place a critical demand upon quality control at every step.

Thorough cleaning of the metal is one of the most vital steps in producing the vinyl-clad laminate. No matter how strong a bond the adhesive is capable of providing, maximum adhesion cannot be attained unless the metal is free from all contamination and presents a good anchoring surface.

The proper degree of cleanliness is achieved by dipping the metal sheets into a cleaning bath to remove all dust, oil, grease or corrosion products. The sheets are then rinsed in clear, hot water to remove all traces of the cleaning chemicals. As a final precaution, they are dipped into a rust-inhibitor solution and then thoroughly dried by forced hot air.

CLEANING

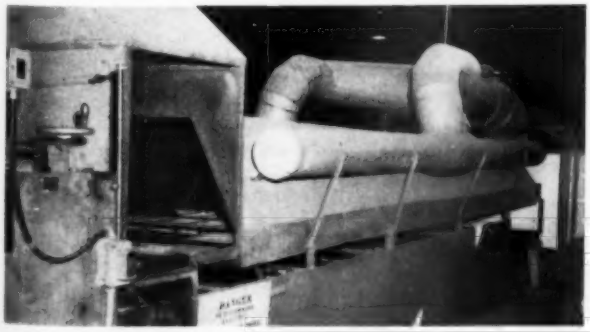


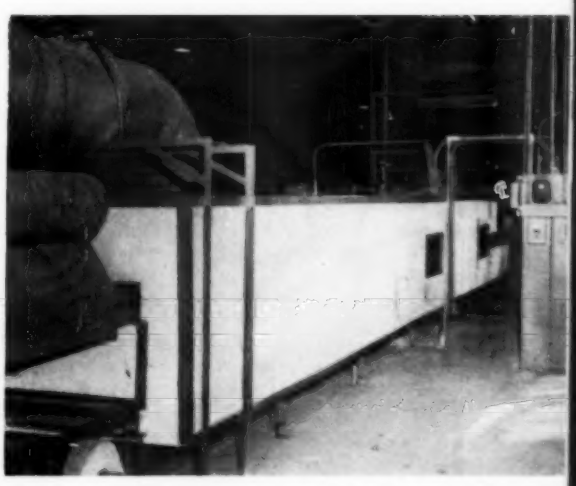
Sheets are loaded into racks which are shown above being hoisted into position for dipping into tank of chemical cleanser. Photo at right shows the rack emerging from tank after the treatment.

COATING

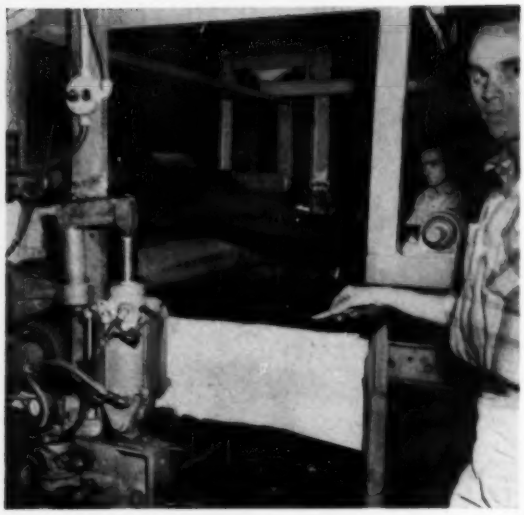
Close-up view above shows how the adhesive is supplied to the roller coaters from a nozzle over the center. An over-all view of the coating setup is shown in the larger photograph at right.

CURING





After adhesive application, the metal sheet is air-dried, above, to remove solvent. It then continues into an enclosed tunnel, right, where it is heated to the proper bonding temperature.



The heated, coated sheets and the vinyl are mated between pressure rollers and the excess vinyl is trimmed from the edges.

Vinyl-clad metal sheets are then passed to a rotary rack where they are held until they are cool enough to allow shearing.

Roller conveyors are used to travel the vinyl-clad sheets to the point where they are cut to size, inspected and packed.

The cleansing operations described are carried out immediately prior to the coating operations. In this stage, the cleansed metal sheets are passed through two roller coaters, set up in series, to receive the first application of adhesive. A steady flow of the low viscosity, high solids adhesive is fed to the rollers which deposit a thin, uniform coating on the metal.

Next, the coated sheets are dried with forced hot air (150°F.) to remove the adhesive's solvent. Once dried, the sheets are again passed through the roller coaters to receive a second adhesive coat which is dried in the same manner as the first.

Removal of all solvent in the adhesive film during the drying cycle is necessary to avoid blistering in the vinyl when the laminate is completed. A drying temperature of 150°F. is optimum since it is high enough for efficient solvent evaporation, but low enough to prevent the solvent from boiling and forming dimples or craters in the adhesive film. These eruptions could produce areas with little or no bond strength.

Uniform adhesive thickness—in the operation described here is a 0.6 mil dry adhesive film accumulated during the two passes through the roller coaters—is a critical factor in making a successful bond. Of course, too thin a coat will result in low over-all bond strength and may also produce areas of no bond at all. However, if the coat is too thick, it is likely to weaken the bond in addition to raising production costs unnecessarily. This variable must, therefore, be carefully controlled.

When all the solvent has been removed, the coated sheets are placed on a conveyor under radiant electric heaters and brought to a bonding temperature of 350°F. At that temperature, the adhesive film becomes tacky enough to produce a strong bond and the vinyl is joined to the metal by passing both simultaneously through rubber nip rolls.

A pressure of 125 pounds per linear inch assures intimate mating of the two surfaces. It should be noted that even at this bonding temperature and pressure the design of embossed vinyl will not be adversely affected.

Immediately after the bond is made, the vinyl is trimmed around the edges and the completed sheets are conveyed to rotary racks. The latter hold and then automatically pass the sheets to the shearing machine when they are sufficiently cooled. After careful inspection, the sheets are cut to size and shipped.

A sales representative looks at

Pressure Feed Application Equipment

By KIRK LIGHTBOURNE
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Chicago 39, Ill.

As an agent-salesman, I am often asked to give my opinion of gluing projects shown to me. I wish to deal here with some questions and problems that come up most often.

My readers will learn that I am not an adhesive chemist, nor am I an engineer. My descriptions and explanations will be in non-technical, layman's language, my assumptions being that the reader may not know psi from cfm or an "air regulator" from an "air compressor."

The questions most often asked are:

(1) Is there a low cost way to replace the brushing-on method of applying glue?

(2) Can we replace stapling, by lower cost gluing, without losing present production rate or man hours?

(3) Why should I glue cases when I am getting speed and cleanliness by taping? Can you justify my changing to gluing without giving me a mess and high equipment costs?

(4) How can I put maintenance costs in my gluing applications?

Maintenance Problems?

Many people have been discouraged from installing low air-pressure methods of obtaining adhesive flow by supposed maintenance problems. This is unfortunate, because properly understood the maintenance procedures are really very simple and easy.

To facilitate understanding of a pressure feed system, remember these two phrases: soft air and hard air.

Soft air is atmospheric air. Soft air will absorb the cutting agents, the solvents, the accelerators from the adhesive. We know this from the scab or crust or skin that forms on the surface of any adhesive exposed to soft air.

Hard air is atmospheric air that has been compressed. There is no room in hard air for absorption of moisture; therefore, it will not accept the accelerators, the solvents or cutting agents of adhesives. With adhesive in a pressure feed tank and hard air "locked" in the tank on top of it, there will be no crust, skin or other factor of flow interruption on the surface of the adhesive.

Hard air is also a strong force pushing downward on the adhesive within the pressure tank. It is the same as a steel disk, the exact dimensions of the tank's inner circumference, being forced constantly downward upon the adhesive by a heavy weight.

Hard air is not a natural phenomenon; we might say it has to be manufactured. Actually it must be compressed within a suitable container. These containers are called "compressed air tanks" or "pressure feed tanks." They are limited as to the quantity of hard air that they will accept. We refer to this quantity as psi—pounds per square inch.

Hard air, then, is like a giant coiled spring held in position by forces stronger than the spring. Extreme care must be exercised in permitting the spring to uncoil, and the same holds true in permitting hard air to escape from the pressure tank.

The psi of hard air within the pressure feed tank combined with the resistance to flow of the applicator are the main factors controlling adhesive flow from a pressure feed tank. Other factors include the viscosity or number of centipoises. In plain talk this simply means the "thickness" of the adhesive. Required psi within the pressure tank is dependent upon adhesive viscosity, and the desired speed and quantity of flow. These factors are resolved by proper fittings and outlets from the pressure tank.

Air regulator valves are used to control the psi of hard air within the pressure tank. These valves are usually used in conjunction with air gauges, which show psi by needle indication on a dial face. When desired flow is obtained by low psi readings on the gauge, it is sometimes necessary to use two air regulators; this is especially true if air source is greater than 80 psi. Two

"Soft air is atmospheric air."

regulators, properly adjusted, will prevent psi from creeping upwards, and thus they will keep flow at desired evenness.

The inside diameter (i.d.) of fluid hoses (pipe or tubing) is also a controlling factor when extremely low pressure within tank gives desired flow. When the distance from the tank to the applicator is ten feet or less, ¼" i.d. hose is usually satisfactory.

In some plants a centrally located air compressor services all air outlet stations. In such cases there is danger that water, oil and dirt from this line may contaminate the adhesive within the tank. Preventative: intercept the air line to tank with an "air transformer". This instrument filters air passing through it and also eliminates most moisture from line. It is obtainable with an air regulator attached.

and combined with the air regulator on the pressure feed tank to give the double regulation described previously.

Certified pressure feed tanks are equipped with safety air release devices or needle bleed valves. These fittings are also necessary for proper maintenance procedures which will be described later.

Most adhesives are manufactured to perform their bonding function tenaciously and quickly; when necessary, however, the proper solvent or cutting agent will prevent this reaction.

"Hard air is manufactured air."

Positive type open and close valves should be affixed between the applicator and the fluid hose. Most professionally designed glue applicators made for pressure feed systems have a positive type fluid valve already installed. However, some of the applicators are of the "home made" type and must be removed from the fluid hose for maintenance after each use. Some sort of positive fluid valve that can be opened and closed must be fitted to the fluid hose.

Adhesive Sealed Off

With adhesive and hard air in pressure feed tank, and with valves and fittings closed and sealed, the adhesive is sealed off from atmospheric conditions and its life in the tank is equal to shelf life. As adhesive is expelled from tank, it is replaced by hard air. The most important maintenance function, therefore, is to keep hard air within the pressure feed tank until it is empty. This means that the air source to the pressure feed tank must be under compression at all times, and the air pressure gauge must show some increment of psi within tank.

Where tanks have a greater than five gallon capacity, or where an internal agitator is required—as when using solvent type adhesives—quick couplings for the fluid hose are desirable. Quick couplings may be removed from pressure tank, attached to hose cleaner and flushed clean of adhesive in short order. (Quick disconnect couplings have a positive, plunger actuated, valve that shuts flow off when couplings are disengaged.)

With pressure tanks of a five gallon or less capacity, simultaneous tank and hose clean out is relatively simple. For tanks with bottom fluid outlets: empty remaining adhesive from tank; pour one quart of solvent into the tank; with psi at 50 or 60 flush solvent from tank through fluid hoses. Repeat the process using clean solvent. With top fluid outlet tanks, place solvent into jar or can that will fit into tank; lower fluid spout into the solvent container and follow directions as in paragraph above. Wipe the inside of tank clean with a solvent saturated cloth.

Most manufacturers of spraying equipment make a flow gun. The tip of this gun is an inverted cone actuated by a needle that retracts, when triggered, from aperture at cone tip. Tips with various orifice sizes are available. They are an excellent tool for laying a bead of adhesive. Some models have pistol grips for easy handling. Maintenance is easy and quick.

The Alemite Company manufactures a pin type fitting. Model A-359 will fit ¼" NPS hose couplings. The fitting is actually a ball-spring type valve. It can serve many useful purposes in applying adhesives. A single unit makes an excellent striper; several manifolded side by side onto a suitably handled bar do the work of a glue-brush. However, the product surface must be of hard material so that in operation the balls of the fittings can be deflected to cause flow. The only maintenance necessary is to place the unit in pan of water (or solvent) when not in use. These fittings are also adaptable for automation on case sealing machines, strip laminating machines, some packaging machines, etc.

The author designed an interesting application of these tips for a Chicago firm. The company used a conveyor to travel cases to the shipping room. Near the end of the conveyor the cases were given a quick, sloppy dab of adhesive from a dripping, messy brush and then manually pushed into a compression belt. The movement of materials was excellent except at the undependable, inefficient gluing station. The company had recently started in business and funds were not available to install an automatic gluing (case sealer) machine.

To correct the situation, guide plows were arranged to bring the case flaps, which were to receive the adhesive, to a vertical position. Rigged overhead and suspended downward were arranged two backing plates of sturdy construction. Spaced 3/16" directly across the backing plates were the multiple-Alemite fittings on a vertical pipe the same dimensional height of the case flaps.

As the flaps entered the space between the backing plates and the Alemite fittings, the extruding balls of the latter were recessed into the fitting, thus permitting glue flow. After the case had traveled past the glue station, the balls of the fittings extruded to the closed position and thus cut off glue flow. Suitable guide plows then brought the case flaps to the proper folded position, and the case entered the compression belt.

Operation Is Simplified

The job of the former "brush man" was simplified to folding the two end flaps correctly and starting the case into the now automatic glue station. Under this new procedure the compression belt speed was increased to carry five additional cases per minute and a very untidy glue station was eliminated. Total cost,

"Hard air is like a coiled spring."

including a short section of conveyor belt with linkage to the existing compression belt line: $318.00. The materials required included a five-gallon pressure feed tank, two outlets, ten Alemite pin type fittings, two 10' lengths of fluid hose and necessary fittings, couplings and fabrication.

Recently, at a large soap manufacturing company, I was asked to provide a practical, but inexpensive, so-

lution to production line adhesive application. The problem was to apply a controlled amount of adhesive on the flap of a new soap container which was too large to enter the automatic gluing station of the case sealers. The product run was not sufficient to warrant modifying present equipment to handle the new case.

In the situation to be corrected, three men were employed to help with the glue application to the container. They were stationed together beside a roller conveyor. Two of the three men were employed to arrange the container in position for the "gluing man", (who wore a long rubber apron, rubber gloves and wielded—with great sloppiness—an ordinary paint roller supplied with glue from a shallow pan which was perched on a table nearby. Afterwards the "helpers" pushed the container into the compression belt. Though it seemed to me that they were sincerely trying, they were unable to keep up with the supply and the overflow caused much of the congestion in the room.

At the end of the compression belt a man was employed to remove the containers and place groups of four into shipping cases. The complaint here was that the ultimate recipient of this case could not open the case without damaging the soap containers inside. It was found that the glue, which was applied too liberally, would run down the sides of the containers and bond them to the shipping case.

Then and Now

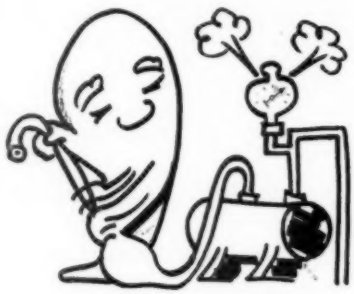
The solution and present operation of this station is now a pleasure for me to witness:

A guide was arranged on the conveyor to direct the containers to the gluing station in a consistent pattern. A "backing" was arranged to permit the container flap to be supported for the brief interval of the glue application. Glue was applied to the outside flap only.

The pressure feed tank was a five gallon, double, regulated unit. Fluid hose was ¼" i.d., but slightly over 10' long. Hose was jigged to a tender coil spring fastened directly over the gluing station. The applicator was a J. P. Fox Model 428, 4½" roller tip, attached to a gun body with an internal fulcrum lever type valve. Pressing the roller tip to the container flap and flexing the gun body slightly caused flow. Quantity was adjusted to the operators speed by psi within feed tank. Production increased immediately upon installation of this equipment. Incidentally, the operators no longer wear the rubber apron or gloves. Glue application is exactly where wanted, with speed and efficiency and no overflow.

The roller tips and fulcrum lever type gun valves used in the operation are available in roller widths of ¼" through 4½".

In another instance known to the author, the manufacturers of large household appliances decided to change from a wood crating to corrugated packaging. The new container was made in three sections, wood reinforcements and platform being used where needed. On the production line, the appliance arrived at the packaging station via an overhead monorail system. The bottom of the corrugated container was placed on a slow-moving conveyor belt. The wooden platform was brushed with adhesive and fitted onto the bottom.



"Hard air is fed into the pressure tank."

At that point, the appliance was lowered onto the platform and a container section equal to the height of the appliance was slipped over and down so that the appliance was covered except for the open top. The top of the corrugated container was now put on and the flaps of the bottom and the top of the container were stapled. Two strapping bands, paralleled and drawn tightly around the container, were fastened on. This completed packaging. It was decided to glue the flaps of the container top and bottom, if packaging time would not be lengthened by this switch. A fast setting adhesive and application method was needed.

After studying the problem, I suggested the following setup:

An ordinary household adhesive called Glue Bond was selected for this application. When a thin coating was applied to one surface and the bonding surface compressed immediately, a peel test in six seconds showed all fiber. However, this set time may not prove true with all types of corrugated cardboard. Three Model 130, 1" diameter Spot Tips of the automatic ball-spring-plunger type were mounted vertically, side by side, onto a multiple tip body

This manifold was then mounted onto a piece of spring steel which, in turn, was mounted so that the plungers of the tips were ½" inside the width of the container. A guide plow fastened onto the multiple tip body forced the spring steel mounting to "give" until the tips were of the same space increment as the width of the container. The Spot Tips could then lay down a very thin film of adhesive.

The container moved into this gluing station via the slow belt conveyor. Directly past the gluing station, guide plows brought single flaps of the container's top and bottom into compression contact with the glue applicator. The compression period was 10 seconds.

By this time the container had moved to the end of the belt. Here a guide plow pushed the container onto a moving conveyor belt that was positioned at right angles to the first belt. A like gluing station was arranged along this belt with identical plow and compression force arrangements. This station was to apply glue to the remaining top and bottom flaps.

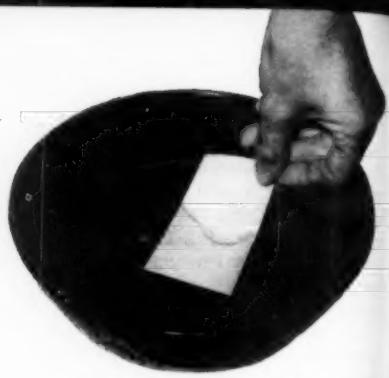
Smooth Flowing Operation

No significant application or maintenance problems have been experienced since this setup was installed by the appliance manufacturer.

Each station used a five gallon pressure feed tank along with six Model 130 Spot Tips: three tips manifolded to two multiple tip bodies. Tanks were "FF" glass lined brand (Glue Bond adhesive has an acetate base) and were double regulated. Fluid hoses were of ¼x¼" i.d. Thiokol.

Cost of application—not including the author's time, shop time necessary for fabrication of mounting brackets and guide plows, or the additional conveyor belt—came to $377.50. This outlay was quickly justified by cost savings in staples alone.

KIRK LIGHTBOURNE explains that he has recently taken to writing about and "dreaming up better applications" for the products he sells.



Simplified industrial maintenance with

Adhesive-Treated Cotton Fabric

Preventive and industrial maintenance work can be simplified at considerable cost savings through the use of cotton fabric impregnated with cellulose resin

At Maue Oil Company, a 210,000-gallon tank which had become leaky after 25 years of service was successfully repaired with an adhesive-treated mending fabric. The maintenance job was completed over a year ago, and the giant tank, which previously had resisted all repair efforts, has shown no further signs of "weepage."

The repair material used at Maue is a cotton fabric impregnated with a cellulose plastic resin. Commercially designated as Celastic, it has long been known to shoe manufacturers who have used it to reinforce leathers for the upper portions of heels and toes, but until five years ago it had few applications outside the footwear production field. However, because of its unusually easy applicational characteristics and adaptability to both routine and preventative maintenance operations, it is finding increasing favor with industrial engineers.

External Application

In the application at Maue, the oil storage tank was repaired by externally applying strips of the impregnated cotton material over all sheet metal joints in the tank, the rivets of which had loosened after a quarter century of service. The surfaces were first prepared by removing all oil and sandblasting. Next, solvent-dampened strips of the impregnated cotton were molded to the joint configurations so closely that rivit heads and overlapping sheet metal edges could be clearly seen when repairs were complete. In the final step, a finish coating of paint was applied, and the tank was then ready to be put back into service.

Celastic is produced by The Celastic Corp., Kearny, N.J. It comes in rolls four feet wide and 25 to 100 feet long, and looks something like heavy gray blotting paper. To be made ready for application, any specific quantity can be dipped into a solvent-type activator solution for about ten seconds.

In this state, it can be strongly bonded to wood, metal, concrete, glass, and many similar surfaces. Only manual pressure is neeed to bring it into contact with a given surface and the bond forms as the Celastic dries and solidifies.

During the solidification process, the material undergoes a chemical reaction which makes it impervious to water, oil, acid or alkaline solutions as well as most volatile solvents. In fact, it cannot be re-softened with its own activator.

Present important maintenance uses for the material include the repair of leaky ducts and fluid storage tanks, the resurfacing of worn or damaged concrete floors, the waterproofing of roofs, and the prevention of corrosion in metal parts that must be exposed to severe operating condi-

Rolls of Celastic look like blotting paper and due to the fabric component can be torn along straight lines into strips of varying widths.

tions. In virtually all instances, results obtained are excellent.

In addition to being chemically inert, Celastic is said to have high tensile strength and better abrasion resistance than either glass fiber laminates or asphalt tile. Further, if decorative finish effects are specified, the material will serve as a primer for stand organic coating dispersions.

Following any given application, Celastic loses its surface tack in about an hour. However, it should be allowed to set for 24 to 48 hours before it is exposed to severe operating conditions. Tests made by applying compressed air to a piece of the fabric adhered to one end of a steel tube have disclosed that the material has enough bond strength to withstand up to 500 lbs. of pressure.

Another user of Celastic is Monsanto Chemical Company, whose plant engineer F. A. Frick has asserted that it is the best material he has yet found for patching mill ductwork systems in areas that have been worn out by abrasion and mild corrosive conditions.

Preventive Maintenance

Preventive maintenance work at Koppers Co., Inc., currently includes the finishing of Aeromaster fan blades with the adhesive-treated fabric. Aeromaster fans are used by Koppers in water cooling towers, where they must handle steam and corrosive vapors which are generated in the manufacture of chemical products. Protected with conventional coatings, the blades had to be refinished, repaired, or replaced at monthly intervals. Now the fans require no maintenance for more than a year at a time.

Conventionally-sealed doors on cold storage equipment take quite a beating because moisture gets into their edges and freezes, raising cain with insulation materials. Engineers for several reliable companies now agree that this doesn't take place when doors are sealed with Celastic.

Temperature Limitation

Incidentally, Celastic isn't recommended for use at high operating temperatures. However, at temperatures ranging from 250° F. down to —109° F., it is exceptionally stable.

Modernistic factories with flat roof structures have been plagued with leaks for years, due to the inadequacies of conventional roofing materials. Celastic is a bit too expensive to compete directly with conventional roofing materials, but it is being used to a growing extent as a joint sealant and quick-repair material by men responsible for roof maintenance.

Skid-proof coatings on floors and stairs are now regarded as a "must" by most factory managers, but unfortunately some still believe that there's no such thing as a floor coating that will stand up for any length of time. This belief is a handicap for the impregnated fabric because it can't compete with conventional floor coatings in terms of initial cost. However, experience in several instances has shown that the material has the thickness, abrasion resistance, and chemical inertness required to outlast conventional floor coatings many times. For example, United Fruit Company has found that Celastic covered decks on seagoing vessels require no refinishing for more than two years at a time. The same decks once required new coatings every three or four months.

Wooden tool handles such as the hammer shown here have been effectively repaired and reinforced with single layers of Celastic allowed to set 24 hours.

A coating roller is used to apply manual pressure to a sheet of the adhesive-treated fabric which will serve as a floor covering. The fabric can be used on boat decks.

Solvent-softened cotton fabric impregnated with a cellulose plastic resin can be used to water-proof boat hulls. The material is more durable than laminated glass fiber coverings.

New Concepts in

Bone Glue Manufacture

By F. G. SHAW, Jr. and L. B. LANE
Armour Alliance Industries
Alliance, Ohio

Animal glue, once associated with packing house waste products and foul odors, has now reached its proper stature in the chemical industry through manufacturing innovations. The bone processing industry today, as seen at Armour plants, for example, is employing the latest developments in mechanical technology.

The term "animal glue" is applied to technical grade products derived from collagen, a naturally occuring protein in skin, bone and connective tissue. Collagen is converted to glue by means of hydrolysis (heating the prepared stock in the presence of water) in much the same manner as in the preparation of soup. Industrial uses of the finished product include gluing, sizing, composition bonding and colloidal applications.

Source of Collagen

The source of collagen is the same today as it was centuries ago when the first batch of glue was produced. However, advanced methods of handling and processing the raw material have been responsible for elevating the resultant product from the common animal by-product category to the status of a special type of organic chemical.

The Adhesives Division of Armour Alliance Industries, Alliance, Ohio, is now producing a glue from edible grade bones at its modern plants in South St. Paul, Minn., and Omaha, Neb. Here, bones from converting and canning operations are collected under food grade conditions and converted to bone glue. These operations, carried out under the eye of the Meat Inspection Division of the U.S. Department of Agriculture, are almost entirely automated, reducing the number of persons formerly required to process the same amount of glue.

Four types of bones are used in the production of bone glue—junk or scavenger bones, butcher bones, dry bones and fresh or green bones.

Junk bones result in the lowest quality glue, especially from the standpoint of odor. The sources of this type of bone are offal from very small slaughter houses and rendering operations, and importations, generally from Cuba. Such bones, collected by commercial scavengers, may be well over a week old by the time they are processed provided they are domestic; otherwise, they are much older. Having received little if any preservation treatment, the residual meat scraps and blood on the bones are in varying degrees of putrefaction. The effects, naturally, are transmitted to the bones themselves causing non-uniformity of quality of the basic raw material. The quality of the glue, therefore, is a function of the age of the bones, the conditions under which they have been kept prior to collection and the extent of degradation at time of use. Impaired quality of bones resulting from holding, degrades rather than up-grades.

Imported junk bones are subject to the same degradation as collector bones. However, the elapsed time occasioned by over-water shipping adds to the spoilage problem. Very often imported junk bones are months rather than days old as in the case with domestic sources. During the winter season, bones from abroad may arrive in good condition, but during the hot, humid, summer weather, the decay, with resultant protein degradation and odor, is very pronounced.

Butcher bones include bones from meat markets (formerly classified as butcher shops), hotels, restaurants, institutions and small processors of meat products. Collectors accumulate these bones periodically for quick delivery to the glue processing plant, but even so the time element in storage and transit takes its toll.

Importation and Collection

Dry bones, of two types, usually are imported from South America. One type originates with a packer; the other is found on the Pampas. Packers specializing in canning operations wash the bones to remove blood and loose pieces of meat scrap. They then degrease the product by means of a solvent extraction process, and follow by spreading the bones on the plains for drying and bleaching by the sun. Such bones, upon arrival at the glue plant, are dry and free from decay.

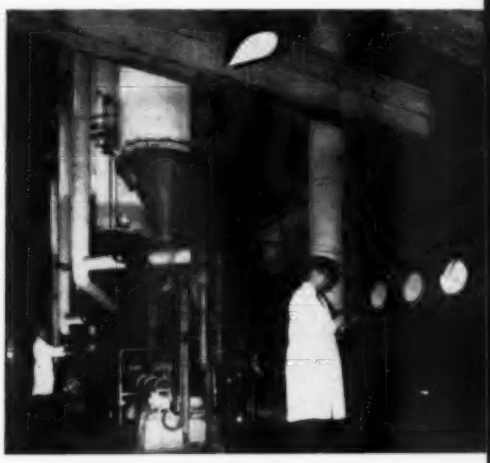
Originally, dry bones were collected from the Pampas, having been deposited there by animals that were killed or that died on the range. The carrion-picked bones were left to dry. Because the region is arid, very little degradation occurred through the years. Over a long period of time, thousands of tons of such bones were collected. Now, however, the dry bone source is predominantly packing plants, although some scattered shipments of desert or prairie bones still are received from South America and from our own western plains.

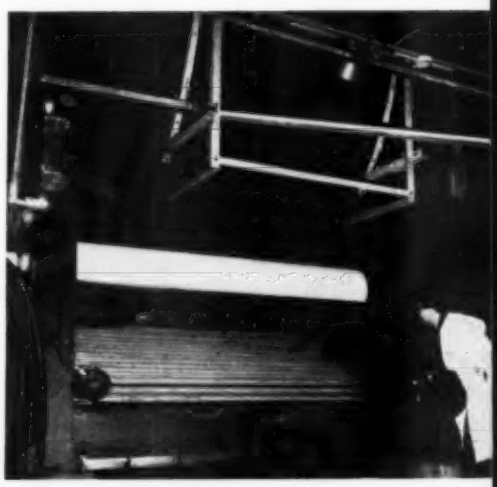
Photo on left shows cooking vessels and conveying system for removing bone residue.

Over-all view (below) of the evaporator equipment and main control panel.

Center photo shows a huge drying drum feeding a glue web into an apron dryer.

The glue goes from the dryers to the grinding mill and then is bagged (bottom).





Fresh or green bones, in packing house parlance, are classified as edible and inedible. They are processed separately in different locations so as to retain their respective status. The edible material is obtained from the boning and converting operations, and is subject to all Meat Inspection Division regulations pertaining to packing house operations during its processing. The inedible bones constitute heads, jaws, feet, cured bones, etc. Irrespective of the type of bones, edible or inedible, they are processed within a few hours after becoming available or before any degradation occurs.

Past manufacturing techniques were very time consuming. The bones were washed, crushed and batch-cooked repeatedly in hot water under atmospheric conditions for approximately a week to obtain practical conversion of the collagen. With the advent of pressure cooking, Armour adopted pressure tanks and techniques for bone glue extraction to produce glue with minimum degradation. The extraction time then decreased to approximately 15 per cent of the old atmospheric method and the cleanliness of the operation was improved many-fold. The present extraction method requires batch-cooking, but the cycles are greatly accelerated.

All of the hydrolyzed collagen, in a dilute state from the various extractions, is centrifuged by means of specially designed equipment to remove any residual grease or tallow and suspended insoluble matter. Modern equipment is used to concentrate the liquor to a higher solids content prior to drying. In the newly developed Armour operation, the concentrated glue liquor is applied to a heated drum for partial drying before passing, in the form of a continuous web, through an apron type drying unit consisting of several individually controlled temperature zones for final drying. The complete drying cycle takes approximately 45 minutes.

Alternate Drying Method

An alternate method of drying involves continuous application of concentrated glue liquor to a steam heated drum which, in one revolution, completely dries the glue to a pre-determined moisture content. In either case the drying time is reduced from days to minutes as compared to the old method of drying in air tunnels, perforated boxes, etc.

The next step entails control testing of each lot passing through the plant to check quality, and to obtain the required technical data for evaluating and grading production. Dried material is milled to consumer requirements and packaged in multi-wall, moisture-barrier, kraft paper bags.

By-products of the glue-processing operations consist of grease, tallows, and animal feed bone meal. The grease is removed by various separation methods such as centrifuging. The residue remaining in the pressure vessels after extraction and subsequent drying and milling operations is bone meal.

The transition from archaic methods of bone glue manufacture to methods embracing latest scientific knowledge has resulted in better glue.

Improved methods of raw material handling and processing techniques have provided a cleaner, fresher and more uniform bone for glue-making. This innovation alone has reduced odor materially in the finished product and definitely has produced better uniformity of glue.

Improved Quality

Utilization of methods to shorten the time required for the various manufacturing steps has also resulted in improved quality. This practice reduces contamination in the form of dirt, rust and bacteria. Automation has contributed greatly to the standardization of plant procedures which have in turn upgraded both test and uniformity.

The protein derived from bone processing is today finding increasing industrial application as a chemical flocculent, as a dispersing agent and as a colloidal medium in addition to its use in adhesives. Modern bone processing techniques have made these new uses possible. It may be that the markets for the new uses of bone protein may one day surpass that for adhesives and related applications.

About the Authors . . .

FORREST G. SHAW, Jr., is Product Sales Manager, Animal Glue Dept., Adhesives Div., of Armour Alliance. He has been with the company since 1950. Mr. Shaw received his B.A. in economics from Northwestern University in 1940. He has also studied at the American Institute of Banking.

LEONARD B. LANE is the Market Development Manager of Armour Alliance. He joined the company in 1924 and worked for three years in the Chicago Research Laboratories. He received his present appointment in March 1959. Mr. Lane received his B.S. in chemical engineering from Purdue University.

New procedures help improve

Bonded Non-Woven Fabrics

In order to broaden the number of uses to which non-woven fabrics can be put, Rubber Technical Developments, one of the research laboratories of the natural rubber growers of Malaya, has recently been conducting a series of experiments directed at minimizing such delamination.

Over the past few years, non-woven fabrics in which the binder is incorporated as an aqueous emulsion have found growing acceptance in the clothing industry. However, one of the problems with this type of fabric has been delamination when the fabrics are to be coated, pressed, or used in conjunction with adhesives.

Initial tests showed that delamination occurs because the latex particles are too small to be trapped in the fibrous structure and are carried to the surface by the movement of water during the drying process. To offset this migration of the latex particles the RTD research team experimented with a number of gelling agents.

Generally, those agents divide into two classes, external and internal. The "external" includes acids and salts of multivalent metals. The applications of these agents involve the use of a double impregnation system, and necessitates washing the fabric to improve color, odor and aging characteristics.

Internal Gelling Agents

The "internal" agents include zinc ammonium salts and non-ionic polymers such as polyvinyl methyl ether and polypropylene glycols. These agents are added to the latex itself before impregnation is effected, and if the latex is suitably compounded, they are inactive at room temperature. When the temperature is raised, however, the agent becomes active and causes the latex to coagulate. As opposed to the double impregnation required for the "external" agent, here only a single application is involved.

Since it developed that internal gelling agents were the most easily applied, the RTD team concentrated its efforts on working with heat sensitive rubber latex compounds formulated with this type of gel.

Based on their experiments to date, Rubber Technical Developments researchers find that heat sensitive rubber latex compounds control delamination of non-woven fabrics by providing the following advantages:

(1) The internal bond is greatly improved. Fabrics can be coated, pressed or used in conjunction with adhesives with greater confidence and ease.

(2) There is an over-all improvement in strength.

(3) The concentration of rubber binder on the surface of the fabric is reduced. There is consequent reduction in surface friction which gives the fabric a more pleasing handle.

(4) Production of high rubber content fabrics is facilitated.

(5) The wet calendering technique enables water to be squeezed out and the ultimate drying time is reduced. In addition, resulting material is more dense, again improving handle of the fabric.

The woodworking molder shown here surfaces four sides of small workpieces and prepares them for subsequent gluing-up. The hopper is fed from supply of short pieces on the truck at the left.
Photo courtesy of Mattison Machine Works

This glue spreader receives block directly from the molder. Spread blocks are belt-conveyed to an automatic lay-up table and then to a hot press.
Photo courtesy Black Bros. Co. Inc.

Gluing-Up Veneer Cores

Many matters must be considered prior to bonding veneer cores to insure adequate bond performance

Preliminary surfacing of wood to be adhesive-bonded is a matter of prime importance. For example, two surfaces to be joined should be perfectly flat so that they can be brought into intimate contact with a reasonable amount of pressure. However, because wood is hygroscopic, this simple pre-requisite often presents problems.

In its efforts to strike a balance with the surrounding atmosphere, wood may change its form somewhat as it either takes on or gives off moisture. Unfortunately, it does not do so evenly; studies indicate that wood has a tendency to shrink considerably more tangentially than radially—in respect to the original position it held in the log. This causes some distortion, the amount depending on the type of wood.

Poplar and white pine, for example, have lower shrinkage differentials than many other species of wood. Since they also receive glue particularly well, they are much favored for use wherever lumber cores are built up preliminary to subsequent veneering.

Face veneers used on lumber-core construction run from 1/16 to 1/20 of an inch thick. Expensive species such as mahogany, walnut and various foreign woods are made thinnest so that as much veneer footage as possible can be obtained from these logs. However, as a general rule, thin veneers do not have sufficient tensile strength to make it practical to lay them directly over lumber cores since they would be ruptured by the possible shrinking or swelling of the heavier material.

Cross-Banding Helps

The practice of cross-banding helps to avoid this. The cross-bands, usually 1/8-inch thick, are applied to each side of the core, their grain being laid directly across that of the core. There is adequate strength in two cross-bands to withstand the strains that may be set up in the core.

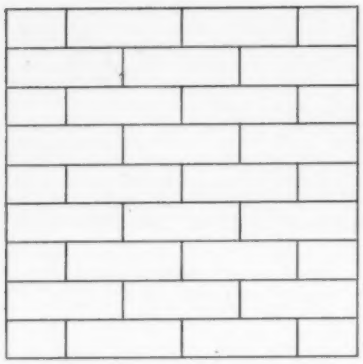
After the cross-bands have been glued in place, the lumber cores are edge-stripped by gluing on strips of wood made from the same type of lumber as will be used for the face veneer. In this way, both lumber core and cross-bands are completely hidden from sight in the finished product. In addition, no edge grain will be visible, except in the thin face veneers, where it will be so small as to be unnoticeable.

Where the greater weight of the finished product will not be found objectionable, so-called "solid" cores are used to make up veneers. They are practically always made up either from narrow strips of glued lumber or from short blocks glued up in courses in such a manner that their joints do not register, as is shown in Figure 1.

The use of short-block cores represents an important economy since they can be produced from the small pieces of lumber which accumulate when larger pieces are cut from shop lumber containing knots and other defects. By processing these remnants into short-block cores, lower grades of lumber can be closely worked.

However, this advantage is considerably diminished unless proper facilities are at hand for fast proc-

Figure 1—Veneer Core Build-Up From Glued Short Blocks



essing. This means modern equipment for surfacing, glue spreading and clamping. The setup should be such that machined wood can be glued as promptly as possible to guard against and minimize hygroscopic distortion.

In many applications, it is advantageous to run parts to be glued together through a wood planer. However, the modern woodworking molder or sticker is a much better machine for fast processing of standard core-blocks, strips, etc., because it surfaces all four sides of a piece of material in one pass through the machine. Some of the modern molders, such as those made by Mattison Machine Works, can be fitted with a hopper at the infeed end so that the operator can keep the machine completely full, even at fast speed.

Short blocks or core strips are often processed through a molder and piled on trucks for transportation to the glue spreader. For most operations, however, a more efficient arrangement is to use a small roll-type glue spreader, like those available from Black Brothers Co., Inc., working in tandem with a woodworking molder. The spreader is installed on a stand high enough to allow the roll opening to register with the lumber coming from the molder.

Both Mattison molders and Black Brothers glue spreaders may be obtained with variable-speed mechanisms incorporated in the feed. Where either or both of the machines are so fitted, the speed should be adjusted so that the glue spreader feeds slightly faster than the molder. In this way, jam-ups between pieces will be avoided at the spreader infeed.

Efficiency can be further extended by setting up a conveyor at the spreader outfeed, so that glue-spread blocks or strips are carried directly to the lay-up table, preliminary to introducing them into a clamp for final squeezing. Here again, it is best to have the conveyor run at a somewhat faster speed than that of the spreader rolls, so as to eliminate all possibility of interference between blocks as they pass from the spreader into the conveyor.

Short-Block Savings

As has been pointed out, considerable savings are involved in the use of short-block or strip-type lumber cores because the materials need not be of the highest quality from the standpoint of appearance. Remember, the cores are completely hidden in the finished product. No attention is paid, for instance, to blue stain, and pin knot or worm holes are of no consequence. Even small weather cracks or other defects which do not seriously weaken the lumber structure may be allowed to go directly into the product.

The same economic advantage is inherent where a piece of heavy material can be made by gluing together several plies of solid lumber. For example, where heavy furniture legs are being processed, a great price savings can be realized because the glue-up process allows incorporation of a considerable amount of lower-grade lumber without lowering the over-all strength of the finished item.

Figure 2—Composite Four-Piece Part Glued Flatwise

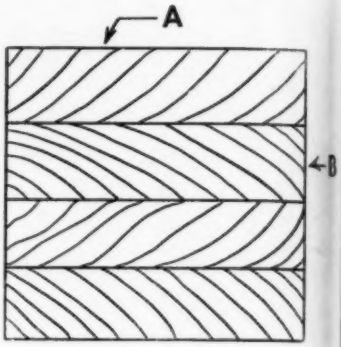


Figure 2 is a line representation of the end view of a composite wood part made by gluing four pieces of material together flatwise. The two outside pieces are designated as "A," and the two inside pieces as "B." Without damaging the strength of the end-product, the two "B" pieces may be highly defective near their center width. They may even incorporate knots of substantial size. The only requirement is that both *edges* of the "B"pieces be perfectly sound.

Similarly, the two outside "A" pieces must show perfectly sound on one side, although they may have moderate surface defects on the other. However, here too, the edges must be good.

A piece of stock glued-up as is shown in Figure 2 is much stronger than a solid piece of the same dimension. This is true because the four pieces in the lay-up never have their major weaknesses at the same longitudinal point in the assembly.

Have a *PROBLEM?*

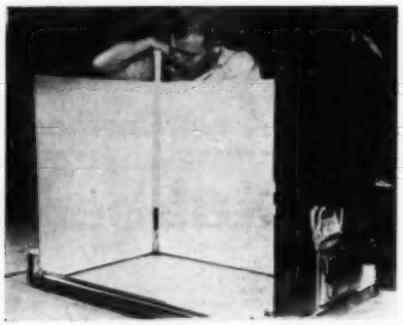
As who doesn't these days. However, if it is a problem involving adhesives, we may be able to help. Drop us a line explaining the nature of your difficulty and we will try to obtain an answer for you. All you need do is address:

Editor: ADHESIVES AGE

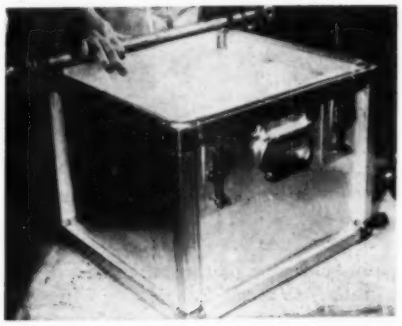
101 West 31st Street, New York 1, N. Y.

Sliding frame extrusion over coated casting.

The epoxy adhesive is applied to the frame extrusion. Use of adhesive eliminates separate gasketing.



Aluminum side panel sheets are inserted into the adhesive-filled integral grooves of the frame.



Simple clamp applies pressure to bonded joints. Case is then squared for oven curing at 350°F.

Cutting Production Costs with Bonded Metal Containers

The use of adhesive bonding to assemble metal, water-tight, lightweight shipping containers has reduced design and production costs approximately 25 per cent at Zero Mfg. Co., Burbank, Calif.

Employed for shipping, housing and storing complex electronic instruments and complicated mechanical gear, these containers must meet rigid military specifications. Many intermediate sizes and shapes are required, and supplying the entire range could present problems of finished goods inventories. Production men therefore decided that what was needed was a container design that could be adapted to small lot or mass production.

The solution to the problem was to adapt a technique known as the Modular Packaging System. It is based on the principle used in erector sets, but the entire container is assembled by adhesive bonding.

Zero's shipping containers consist of slotted aluminum extruded frames with stressed aluminum side sheets in a tongue and groove design. The extrusions are first adhesive bonded by means of corner castings. Once the framework is formed, the sides of the container are then inserted into the extrusion grooves and adhesive bonded.

High Heat Unnecessary

Joining with adhesives does not require the high heat necessary for welding or brazing operations which often tend to distort the container shape. In addition, adhesives produce continuous bonds and thus distribute stress loads evenly over the entire joined area. This eliminates local stress concentrations common with mechanical fasteners, and produces joints of greater strength and rigidity with lighter gage materials.

An added advantage of the adhesive method is that production operations are simplified by the elimination of close-tolerance machining of mating parts because the adhesive—Minnesota Mining and Mfg. Co.'s EC-1386—is an epoxy with void filling properties. In addition, use of an adhesive eliminates the necessity for a separate sealing operation to make the container water-tight.

During assembly operations at the Zero plant, the extrusions are first cut to length. Special corner castings containing integral cast adhesive reliefs are used to form each corner. The corner casting reliefs are filled with the one-part epoxy and the extrusions slipped over them.

When the framework of the containers has been assembled, then the grooves which are an integral part of the frame extrusions are filled with the 3M epoxy. The stressed aluminum sheets are next inserted into the grooves on the frame.

After the entire container is assembled, it is squared and banded with a steel strapping tape to hold it in shape. The entire unit is then placed in an oven to cure at 350°F. for one hour. At the end of this time, the case is painted and interior bracketry and other accessories are added.

A new method for evaluating

Rubber-to-Metal Adhesion

Previous techniques for testing bond strength are thought inadequate since today's researcher is no longer interested in "go no-go" results but in the differences between bonding systems

By G. W. PAINTER
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Lord Manufacturing Co.
Erie, Penna.

In measuring the strength of a rubber-to-metal bond, it is often adequate to demonstrate that failure occurs in the rubber rather than at the bond. Typical of such tests is the sampling of manufactured bonded rubber products. When the test objective is the comparison of the strengths of bonds obtained with various adhesives or the effects of other variables, the requirements become considerably more demanding. A "go, no-go" test is no longer an adequate one, for the experimenter desires not only to distinguish between relatively good bonds and virtually no bond at all, but he also wants to be able to detect differences between systems, all of which have relatively high bond strength. It is the writer's contention that none of the presently accepted and widely used rubber to metal bond evaluation tests are sensitive enough to meet these requirements.

In a recent series of "round robin" tests in which a modified ASTM adhesion test was being evaluated, it was necessary to use inferior bonding techniques purposely to obtain a bond failure; otherwise no data would have been available for comparing the modified method with the parent method. Those who have had experience with existing methods are probably aware that interpretations of bond strength, based on a visual observation of a failure in which both rubber and bond are in evidence, are often incorrect. Quite often, an inspection of the breaking force will lead to an opposite conclusion. This paper discusses the test results obtained with a new rubber-to-metal bond evaluation technique which appears to overcome the difficulties of present methods.

In the course of developmental work on an experimental vibration isolator, it was found that a certain metal surface contour to which the rubber was bonded consistently gave a low bond strength despite repeated efforts to improve adhesion. Inspection of the metal part after an ultimate strength test revealed that one portion of the area to which the rubber had been adhered was virtually free of rubber. It appeared that failure occurred at the rubber-adhesive interface, although in one or two instances the metallic surface was in evidence. These results indicated that we could possibly exploit our difficulties to an advantage and develop a superior test for evaluating rubber to metal bond strength.

It seemed reasonable that we could develop a metal surface contour which would virtually assure a bond failure over the entire area. After several attempts, we arrived at the specimen shown in Figure 1, in which the rubber was bonded between two opposing metal parts having conical adhesion surfaces. It was found by the visual inspection method used in the tests that this specimen not only gave failure at the bond in almost every case, but that the scatter between test results on "identical" specimens was remarkably small. Reproducibility of the test results and the sensitivity of the test can perhaps be best indicated by a discussion of three experimental test programs in which the new

Figure 1—Conical Adhesion Areas of Type III Test Specimen

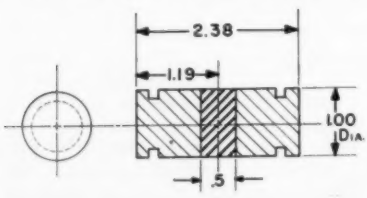


Figure 2—Breaking Forces Obtained with Four Adhesives Used with Type III Specimens

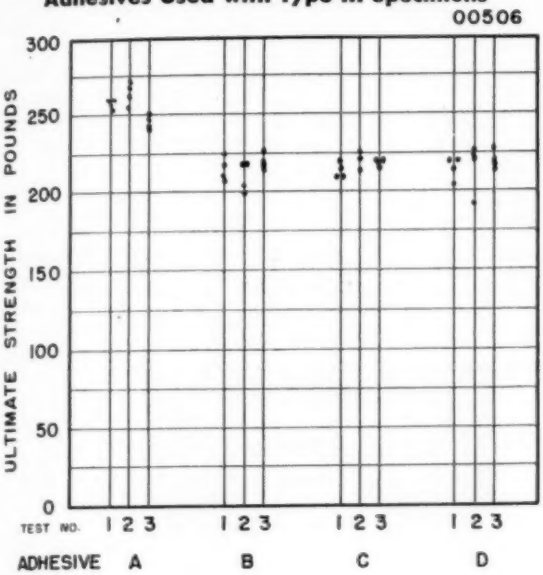
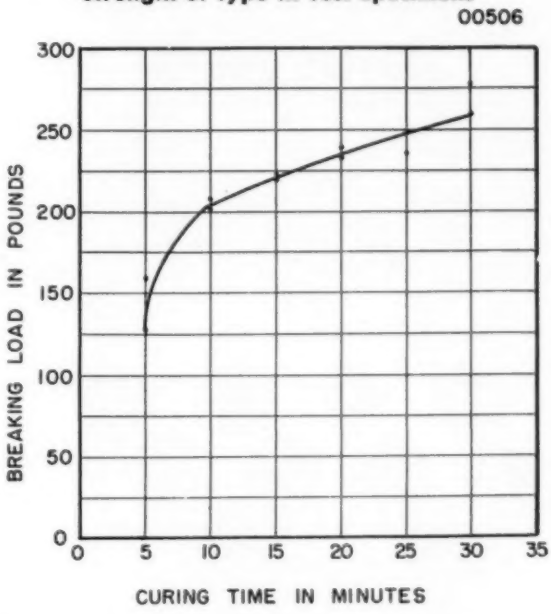


Figure 3—Effect of Curing Time on Adhesive Strength of Type III Test Specimens



bonding evaluation technique was used.

The objective of the first test was one of comparing the bond strength of four commercially available adhesives using the same natural rubber compound in all cases. Test specimens were made with each of the four adhesives and broken. After a two week period, an additional group of specimens was made from the same compound and tested. The same procedure was followed after an additional two week period. The results obtained are shown in Figure 2. The data presented here reveal that the strength of rubber to metal bond was remarkably reproducible. Three of the adhesives gave almost identical bond strength while the fourth was consistently superior, although not markedly so.

In a second test program it was desired to determine the effect of curing time on bond strength. Two specimens were cured at each curing time and the breaking loads are indicated in Figure 3. Here again the reproducibility of the test results is seen to be excellent and the effect of curing time upon bond strength is clearly in evidence. In no case did a visual examination of the metallic surface show rubber to be present.

The object of a third test program was one of comparing the sensitivity of the new test method with other types. The following methods were evaluated from the standpoint of their ability to detect any difference in adhesion resulting from grit blasting the metal parts:

(1) Specimen Type I—90 degree stripping test (ASTM designation D429-56T, Method B);
(2) Specimen Type II—Rubber part bonded to parallel metal surfaces—similar to ASTM designation D429-56T, Method A (Figure 4);
(3) Specimen Type III—New method with conical metal parts (Figure 2).

Chemlok 220 adhesive was employed and the composition of the rubber compound was as follows:

Smoked Sheet	100
EPC Black	25
ZnO	10
Stearic Acid	2
Pine Tar	2
Neozone D	1
Altax	1.5
Methyl Zimate	0.2
Sulfur	2.75

Half of the test samples, for a given specimen type, were made with metal parts which had been degreased with trichloroethylene, and the remaining half were degreased, grit blasted and degreased again. A Dillon Tester was used to measure breaking strength. The following total number of samples were evaluated for each type: Type I—12, Type II—20, Type III—12.

All Type I specimens had a 100 per cent rubber failure and the only conclusion as to the effect of surface treatment which could be reached was simply that in all cases adhesion was sufficient to prevent a failure at the bond.

Type II specimens gave an erratic pattern of failure. Six of ten grit-blasted specimens had virtually a 100% rubber failure, while only one of the ten samples whose metal parts had been only degreased failed in the rubber part. The breaking loads (below) gave no indication of a

Figure 4—Schematic of Type II Specimen Showing Rubber Bonded to Parallel Surfaces

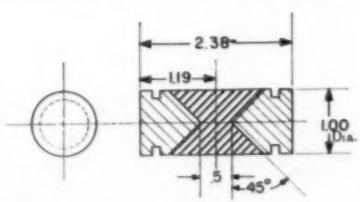


Figure 5—Test Specimens Type II and Type III After Failure

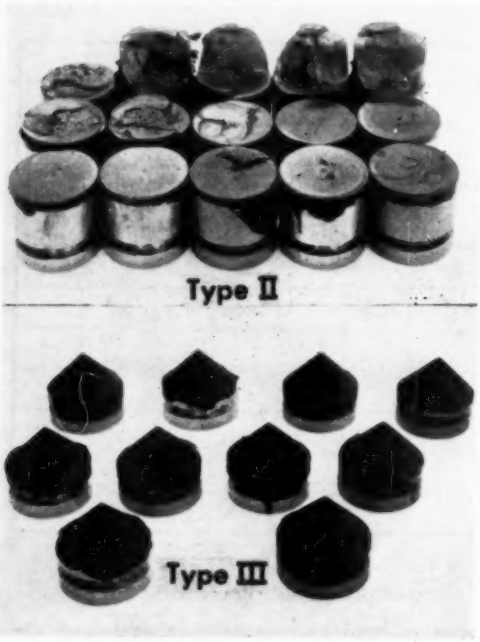


Figure 6—Diagram of Photoelastic Specimen Tested for Constant Shear Stress

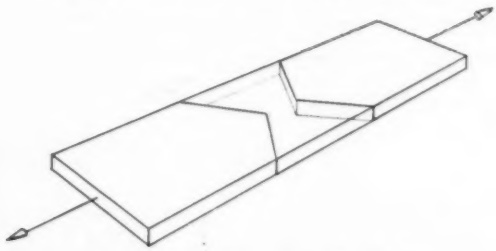
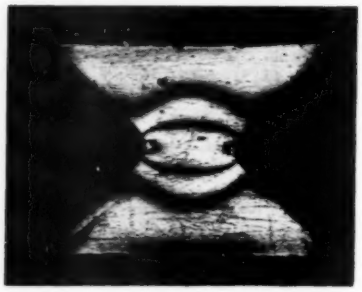


Figure 7—Photograph of Isochromatic Lines Obtained Under Constant Stress



difference in adhesion due to surface treatment.

Type II Specimen No.	*Surface Treatment*	*Breaking Force (Lbs.)*
1	Degreased	1330
2	"	1310
3	"	1475
4	"	1215
5	"	1375
6	"	1245
7	"	1375
8	"	1310
9	"	1200
10	"	760
Mean		1259
11	Grit Blasted	1215
12	"	1210
13	"	1375
14	"	1250
15	"	880
16	"	1325
17	"	1040
18	"	1425
19	"	1340
20	"	1310
Mean		1237

Type III Specimen No.	*Surface Treatment*	*Breaking Force (Lbs.)*
1	Degreased	165
2	"	134
3	"	161
4	"	147
5	"	163
6	"	147
Mean		152
7	Grit Blasted	188
8	"	180
9	"	188
10	"	196
11	"	198
12	"	190
Mean		190

Type III specimens all failed at the bond. The breaking force data indicated that a superior bond was achieved in specimens whose metal parts had been grit blasted. A variance analysis of results obtained on Type II and Type III specimens is given in Table I. The analysis indicates that with Type III specimens the probability that grit blasting gives a superior bond is greater than 99.5 per cent! The difference in bond strength obtained for the two surface treatments in Type II specimens is not statistically significant. A photograph of broken Type II and Type III specimens is shown in Figure 5.

Stress Concentration

The tendency of the conical specimen to fail at the bond rather than in the elastomer, even when the adhesion is excellent, apparently results from stress concentration in the vicinity of the bond. As the specimen is loaded, failure begins at the points of the cones and progresses down along the sides until it is complete. If, after failure, the elastomer is cut away from the opposite end, one almost invariably finds that the failure is almost complete at that end also.

An attempt was made to examine the stress distribution by loading a photoelastic specimen of the type shown in Figure 6. It will be noted that the metal parts in the photoelastic specimen were wedge shaped rather than conical and that the elastomer (actually a flexible epoxy material) had flat sides. Although the photoelastic model was quite different in shape from the test specimen, it appears reasonable to assume that the general pattern of stress distribution is somewhat similar.

Figure 7 is a photograph of isochromatic lines (lines of constant shear stress) obtained under load. It can be seen that the highest stress occurred at the cone ends and that minimum stress occurred at the outer boundaries of the elastomer. Although we have obtained no photograph of isochromatics during failure, the nature of the failure in the adhesion test specimen would indicate that the stress remains concentrated along the circle where the elastomer is peeling away from the metallic cone.

In conclusion, it is important to point out that in some instances the new test specimen has not given a failure at the bond. Elastomer failure can result when the elastomer has very poor tear strength and the adhesion is excellent. In most instances, however, the method has given highly satisfactory results and has proved to be exceedingly sensitive.

ACKNOWLEDGMENT

The author is indebted to Mr. William DeCrease of the Hughson Chemical Company who supervised the preparation and testing of the specimens used in the third test program.

Table I—Analysis of Variance

TYPE II SPECIMENS

Source of Estimate	*Sum of Squares*	*Degrees of Freedom*	*Mean Square*	*F*
Between Metal Treatments	2,531	1	2,531	.07*
Within Treatments	584,133	18	32,451	
Total	586,664	19		

TYPE III SPECIMENS

Source of Estimate	*Sum of Squares*	*Degrees of Freedom*	*Mean Square*	*F*
Between Metal Treatments	4,144	1	4,144	43.6**
Within Treatments	949	10	94.9	
Total	5,093	11		

*Not statistically significant.
**Very highly significant.

Simplified Trailer Top Repair

An adhesive-sparked technique makes use of a fiber glass membrane to effect long-term repair of seams and corners

A recently introduced four-step technique employing a rubber-based cement, a fiber glass membrane and a silicone compound is said to provide long-lasting repair of trailer top roof leaks. Though caulking is the conventional method of making such repairs, many truckers feel that it provides only temporary protection.

According to The Monroe Co., Inc., Cleveland, Ohio, manufacturers of the trailer repair kit, the materials make it possible for any handy man to repair roof seams, corners and edges. The simple procedure is said to prolong the roof life and stop further damage from possible leaks and tears.

The first step in the technique is to dry the surface and clean the break thoroughly. Next the rubber-based cement is brushed on, filling the break completely and extending two inches on either side. The fiber glass membrane is then embedded in the cement. In the final step, the membrane is coated with an aluminum finished silicone compound and the trailer is ready to roll.

Cement is used to fill the seam completely and to coat two inches on either side.

A rot-resistant fiber glass membrane is then embedded in the cement coat.

Application of the aluminum finished silicone compound protects the seam.

Adhesive Bonding Reinforced Plastics

Some of the practical aspects of adhesive bonding discussed include measuring, mixing, spreading, and drying as well as the use of pressure and heat

By RICHARD H. WAGNER*

The processes involved in the bonding of reinforced plastics to themselves or to other materials include the forming, machining, finishing and cleaning of adherends; the preparation of the adhesive; dispensing and spreading the adhesive; aligning, joining and curing the bond; removing the flash and trimming; and postcuring of the assembly. In addition, the total process also necessarily includes housekeeping and cleaning adhesive handling equipment. The details and the degree of control required at each step are dependent on the type of materials involved, on the type of joint being made, and on the quality of joint demanded. Each phase of the bonding process will be discussed in this article.

Forming and molding adherends to the desired shape in preparation for adhesive bonding is highly desirable for various reasons. For example, work to be done in subsequent machining operations is minimized by this preparation, thus reducing equipment, manpower, inventory, scrap and reject costs. In reinforced plastics, minimizing the amount of machine work to be done reduces the danger of damaging the adherend, since the temptation may be great to use heavy cuts and to let the tool grow dull. Molding reinforced plastic adherends in preparation for bonding is closely related to the bonding process and the pertinent factors involved will be discussed.

The factors involved in designing a part and choosing a molding process for a reinforced plastic adherend include the type, direction, and concentration of reinforcement in the region of the part which is to be bonded; the void-freeness of the region to be bonded; and the type of resin and cure cycle to be used in the molding. The type of reinforcement and its finish have a marked influence on the strength of the subsequent adhesive bond. The orientation and concentration of fibers in a reinforced plastic have an influence on the elastic and stress behavior of a joint. The relative strengths of reinforced plastics in interlaminar shear and tension using various laminating resins should also be considered.

In designing the mold it is desirable to dimension the part so that sufficient material is available to permit removal of the release agent and the surface resin, and exposure of the reinforcements. If the bonding surface is to be near or at the end of the molded part, the part should be molded in sufficient length so that starved and poorly molded ends can be cut away. This will allow the quality and glass content directly beneath the bonding surface to be kept uniform and reproducible.

Cutting and shaping molded reinforced plastic parts in preparation for bonding are operations critical to the quality and reliability of the joint. A good reinforced plastic part can easily be ruined in the machining operation by removing too much stock, by producing irregular bonding surfaces, by shattering the reinforced plastic just below the surface to be bonded, or by contaminating the surface.

The causes and effects of the first two possibilities are quite obvious. The piece from which too much stock has been cut should be discarded; it is usually unsafe to attempt to build up the deficient dimensions by patching. Irregular surfaces may not fit, or if they do, may be the cause of hidden stresses in the joint after bonding. Therefore, they should be remachined to accurate dimensions. Shattered parts should be discarded. Contaminated surfaces should be cleaned thoroughly, and even then should be treated with suspicion.

Beware of Dull Tools

Heavy cuts and dull tools cause the reinforced plastic underlying the bonding surface to be shattered because of the large stresses which are generated in the cutting process. Since glass fibers and other inorganic reinforcements are relatively hard substances, they induce rapid wear in ordinary steel cutting tools, saw blades and drills. The wear may be so rapid that the tool may be dulled before a cut can be finished.

*This article is the result of a project sponsored by the Reinforced Plastics Laboratory of the Owens-Corning Fiberglas Corp., Ashton, R.I.

In manufacturing folding type tables, adhesive is applied to aluminum frame and laminate back side.

Laminate is positioned on the frame. An advantage of the adhesive technique is that sheet can be adjusted while before cure.

Laminate is next centered on the frame. The photos here are used by courtesy of the Minnesota Mining and Manufacturing Co.

Pressure is applied to the table assembly with a special bonding fixture and unit is removed after a 45-minute cure.

Accordingly, diamond or tungsten carbide tips and teeth with a high clearance and a negative rake are required for the proper cutting of glass fiber reinforced plastics, particularly in the preparation of bonding surfaces. There is sufficient wear on tungsten carbide tipped tools so that it is necessary to resharpen them from time to time. Great vigilance should be maintained on the sharpness of these cutting tools. Even with the sharpest tools the cut should be light. The speeds and feeds recommended for brass are usually satisfactory.

Cut-off operations are quite satisfactory for the preparation of clean, unshattered surfaces made to close tolerances and to a high finish, provided that diamond cut-off saws running at extreme peripheral speeds are used. It should be noted that the so-called rigid polyesters, and some of the rigid-flexible mixtures, are particularly susceptible to shattering in cutting and grinding operations.

Some epoxy laminates appear to be considerably more resistant than polyesters to shattering during cutting and grinding. Since the phenolics and other types of laminates are opaque it may be hard to determine by visual inspection whether the material is being shattered. A good test of a given technique is to grind a new surface on a translucent rigid polyester laminate and in so doing see whether the translucency is maintained.

Extreme pressures should be avoided in chucking or clamping the reinforced plastic part in preparation for cutting or grinding. High pressure may cause local crushing of the laminate. It may spring the part out of shape so that the dimensions will be irregular when the part is released. Reinforced plastics have between ½ to 1/10 the stiffness of aluminum, and between 1/10 and 1/30 the stiffness of steel. They will deflect accordingly under a given clamping load.

Not all reinforced plastics are impermeable when the outer layers of resin are removed. Oils can soak into the surface and impede adhesion later on. Solvent wiping is not very efficient as a method for removing absorbed oil from a cut surface. Therefore, cutting fluids and coolants containing oily substances should be

Workman applies adhesive from a paper cone to the flange of a truck-body part. (Photo courtesy of Molded Fiberglass Body Co.)

banned from the reinforced plastic machining room. Neither should a shattered surface be wiped with an oily rag or thumb to make it look translucent!

Trichlorethylene, when hot softens the surface of the reinforced plastic and permanently weakens it for bonding. Therefore, the vapor degreasing of reinforced plastic parts should be avoided. It is important to avoid absorption of industrial contaminants, including stray vapors, after machining. Finished parts should be bonded as soon as possible after machining. and should be handled with clean cotton gloves to avoid fingerprints.

Adhesives sometimes fail to bond properly in seemingly random areas of a joint. These inconsistent results can often be explained by the presence of absorbed gases, water, oil, or other materials on the surface of the part. Foreign matter only one molecular layer in thickness is sufficient to prevent proper bonding(*1*). Foreign substances may be difficult to remove and may not be visible to the eye. Special cleaning, handling, and storing techniques are often needed to obtain reproducible bond strengths.

Glass fiber reinforced polyesters, phenolics, epoxies, melamines and other thermosetting resins may be cleaned by wiping with a rag saturated with methyl ethyl ketone, acetone, or toluene (*2*). Thermoplastic resins and fibers are deleteriously affected by aromatic or chlorinated solvents and special care should be used when cleaning them. The part should be allowed to dry for thirty minutes before bonding.

Abrading the joint area with silicon carbide paper will create a fresh, clean surface on reinforced plastics. Note that it is the absence of foreign materials, rather than surface roughness, which generally increases bond strength. Light sand blasting followed by an air blast to remove the dust can also be used.

Metals to which reinforced plastics are to be bonded can be cleaned by wiping with a cloth saturated with toluene or methyl ethyl ketone, followed by trichloroethylene vapor degreasing. Wire-brushing, sand-blasting, and roughening with emery cloth are widely used in place of vapor degreasing. Detailed cleaning recommendations especially for metals used in the aircraft industry, may be obtained from the adhesives manufacturers. Acid bathing is commonly used to etch metal surfaces prior to bonding. A typical treatment for aluminum or Alclad is immersion in a chromic acid-sulphuric acid solution at 160°F. for five to ten minutes, followed by a water-rinse.

Preparing Surfaces

Rubber surfaces should be sanded or roughened with a scraper and then cleaned with a cloth saturated with naphtha. Cyclizing by immersion in sulphuric acid or by application of a sulphuric acid-barytes paste should follow. Thorough washing and drying is the last step.

A quick and reliable method for determining surface cleanliness is the water drop test. It has been borne out in experiments(*3*) that good bonds usually result when a water drop, deposited on the clean surface prior to adhesive application, spreads out into a very thin layer. A dirty surface would cause the drop to remain in globular form. There is correlation between the water drop contact angle and the strength of the joint. Distilled water should be used to avoid leaving a deposit.

The properties of a cured adhesive joint are very dependent on the proportions of the ingredients and on the thoroughness of the mixing operation. It is, therefore necessary that the ingredients be measured and proportioned very accurately and be mixed together thoroughly. Only then can cured bonds be obtained which have uniform properties throughout the joint and which are uniform from piece to piece.

The adhesive supplier can advise on the accuracy to which the components of a given adhesive should be proportioned. When preparing rather small batches of adhesive which call for small percentages of certain ingredients the permissible error in the weighing may be as little as one milligram. In the preparation of larger batches for production use, it may be desirable to employ accurate scales or rather precise proportioning pumps in dispensing the ingredients for mixing.

Many adhesive compounds are difficult to stir and mix. Catalyst or curing agent can lurk in a corner of a vessel and may not be mixed into the mass being stirred. Later this portion of the mass may be spread on the surface to be bonded where it may harden prematurely. The remainder of the mass may be deficient in catalyst and, consequently, may cure very slowly or not at all. The result may be an incomplete or a weak bond.

The more viscous adhesive mixtures are the most difficult to mix thoroughly. Extended mechanical stirring causes air to be entrapped in the mixture. These air bubbles act as stress concentration points in the cured film. To avoid the problems of air entrainment, and the lack of time when mixing short pot-life adhesives, special machinery for metering, mixing, and dispensing the adhesive can be obtained. The special equipment stores the primary resin and the hardener separately, and only enough for immediate use is mixed. The mixing occurs at the nozzle in order to avoid the presence of catalyzed resin in the machine.

Adhesives for reinforced plastics are generally supplied as liquids, pastes, or supported films. For proper spreading, adhesives are generally applied in liquid form, or are liquefied at some stage in the bonding process. Liquid adhesives lend themselves to brush, dip, spray, or roller coating if they are of low viscosity. Higher vi-

cosity liquids may be applied by knife, spatula, or caulking gun.

In some designs it is possible to inject the adhesive into the closed joint under pressure. Film adhesives are often preimpregnated glass fabrics, the cloth acting as a carrier and a reinforcement. This type is cut to size and laid in place at the joint. It should be somewhat tack-free to allow easy handling.

Film adhesives automatically assure a uniform thickness glue line throughout the joint. This type is somewhat different from unimpregnated glass fiber cloth or mat which can be laid in place after the adhesive has been spread on the part. Both preimpregnated and unimpregnated material, however, can considerably improve the joint strength (*4*) Adhesives in some instances must be applied to vertical surfaces and in these cases the tendency of the adhesive to flow downward can be a problem. The use of higher viscosity thixotropic adhesives allows more time for application and permits more uniform spreading.

Techniques Vary

Application techniques for a powdered adhesive is a bit different. For example, Redux, a phenolic-vinyl modified adhesive, has two components: a liquid and a powder. After the liquid is spread uniformly over both surfaces, the powder is sprinkled onto a tacky liquid. A hand operated flour sifter can be used for small areas, or a regular window screen for large areas. The excess dry powder is removed by inclining and tapping the coated surfaces, or by blowing it away with air.

The application technique to use depends on the number of pieces to be coated, their size and shape, and the availability of equipment on hand. Equally good results can be obtained with most methods, provided that the proper adhesives are selected, the parts are properly prepared, and the manufacturers' recommendations are followed.

The uniformity of the film spread on the surface to be bonded can have a significant effect on the strength of the joint. Any occluded air in the pressed bond will cause voids which will act as stress-raisers under load and weaken the joint. If the adhesive is distributed nonuniformly it may be impossible to assemble the joint without entrapping air in the joint.

Two conditions may prevail in a spread adhesive layer. In one case the adhesive lies in ridges along the edges of the joint. It is unlikely that all of the air can be squeezed out of the joint when this condition exists. Since the air is trapped near the center of the bonded area, the horizontal flow of the adhesive in this area is nil. Accordingly, the bubble can be made thinner by additional pressing; but it cannot be eliminated.

By contrast, the condition of the adhesive being spread thicker in the center of the bonding area will be of great assistance in purging any entrapped air out of the joint. In this case the mounds touch before the rest of the area of the joint is assembled. This contact area spreads in all directions, thus, excluding the air from the joint.

Sufficient adhesive must be applied to adequately cover the mating surfaces. Four to eight mils is the generally recommended glue line thickness, although one adhesive manufacturer reports thicknesses of from one-half mil to forty mils as being satisfactory (*5*). No significant variations in bond strength were observed within this range; the joints were of the plain lap type, using epoxy to join aluminum adherends. Other data with a nitrile phenolic show a marked variation of strength with film thickness in the same range.

Allowance should always be made for sufficient adhesive squeeze-out to insure that no starved areas exist. For neatness in the finished product the excess adhesive is sometimes scraped off. However, it has been noted in some tests that the squeezed out material acts somewhat like a fillet in a welded joint by helping to reduce stress concentrations. Strength reductions of from 15 to 35 per cent have been reported when flash was removed by grinding from butt joints between glass fiber reinforced plastic and stainless steel. It therefore may be very desirable to allow the flash to remain as a fillet.

If solvents are present in the adhesive or primer, they must be dried out before bringing the mating parts together. Large amounts of solvent are contained in spray-type adhesives and may also be in those used for brushing or dipping. Entrapped solvent will boil under normal curing temperatures and will create bubbles in the adhesive layer. These holes become stress concentration points. To avoid the problem, a sufficient air drying period before assembly should be allowed.

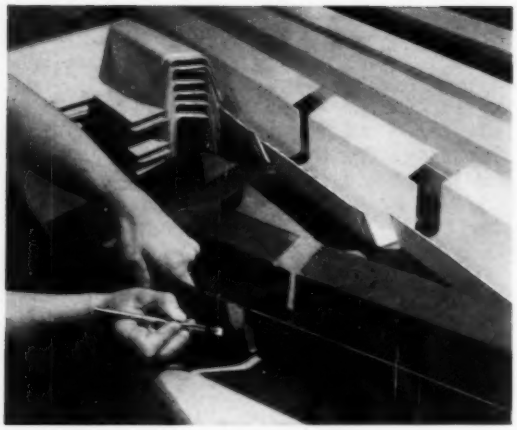
Speeding Cure

Heating will shorten the required drying time, but a drying rate that is too rapid may cause an outer skin of resin to form, causing entrapment of undried solvent underneath this skin. Caution must be excercised when drying adhesives intended for room temperature cure. Their high catalyst content for promoting the curing reaction limits the allowable time between adhesive spreading and clamping. Epoxy adhesives usually have no volatile solvents. With these types, excessive exposure of the spread adhesive may result in partial evaporation of the curing agent and may cause a weak bond.

Temperature, pressure and time are the three basic variables in curing of a bond. These quantities differ widely from one adhesive to another, and depend largely on the catalyst system that is used. Generally, a lower curing temperature will require a longer curing time. Optimum curing conditions are usually recommended by the adhesive manufacturer.

Pressure during curing has several functions. The coating of adhesive must be reduced to a thin continuous

Riveting spare-tire well for a truck after applying adhesive eliminates need of a curing jig. (Photo courtesy of Molded Fiberglass Body Co.)



Reinforced plastic rain gutter shown being brush coated with epoxy adhesive. (Photo courtesy of H. B. Fuller Co.)

layer of uniform thickness. Most forms of adhesive spreading are likely to cause unevenness, and in the case of corrugated roller spreaders, the adhesive is actually applied in a series of ridges. Pressure also eliminates entrapped air and forces the adhesive to flow into irregularities in the surfaces of the materials being bonded. The latter is particularly important when only one mating surface is spread with adhesive.

The use of pressure also aids in avoiding bubble formation caused by volatile material in the adhesive. In addition, pressure holds the two adherends in their proper relative position during the cure.

For maximum bond strength, pressure should be maintained at an almost fixed level during the cure. Parts to be joined must mate intimately. The closer the fit, the less the pressure needed to keep them in contact. Perfectly fitted joints theoretically may not require any pressure for successful bonding, especially when contact pressure adhesives like epoxies are used. With comparatively short lengths of overlap, it has been found that higher bonding pressures increase joint strengths (*4*).

Regardless of the means of exerting pressure during cure, two rules may be applied regarding thermal expansion. To help alleviate residual stresses after curing at elevated temperatures, first, if possible, all portions of the die or alignment fixture should be heated to a uniform and constant temperature. Cold or hot spots will produce nonuniform expansion, resulting in either warpage of the cured joint or undue stress on the bond.

Second, again if possible, the parts, especially when each has a different coefficient of thermal expansion should be allowed to reach maximum expansion before pressure is applied. This can be done by placing the assembly in the curing fixture and by not exerting full clamping force until the parts have been warmed. An alternative to attaining maximum expansion before clamping is to bring the adherends and adhesive to the optimum intermediate temperature to get the minimum differential shrinkage between them. This temperature, however, is difficult to attain in practice.

An Ideal Situation

The ideal situation, practically impossible to obtain, would be to heat each of the adherends to a different temperature, so that upon curing and cooling the shrinkage of each will be the same. A flexible rubbery adhesive will accommodate differential shrinkage to some extent. The addition of a low shrinkage filler to a rigid adhesive will reduce the stresses that are developed upon cooling.

Heat is used to cure the adhesive within a reasonably economical time. Some adhesives can be cured at room temperature by the addition of sufficient catalyst or hardener. Accelerated adhesives, however, also have the disadvantage of a short pot life.

Elevated temperature curing, in the 200°F. to 300°F. range, is generally employed when using epoxy and polyester adhesives. Adhesives intended for use at elevated temperatures, such as phenolics and silicones may have cure temperatures in the range of 300°F. to 500°F. The rate of heating is important, especially when the adhesives are in the form of films, powders, or semi-solids. Too low a heating rate may cause curing before the desired flow takes place. This prevents adequate wetting of the adherends, producing weak areas in the joint. Heating too rapidly may cause the adhesive to become so fluid that excessive flow-out will cause an adhesive deficiency.

If volatile solvents are used as a carrier for the adhesive, substantially all the solvent must be evaporated prior to closing the assembly. This is particularly important when reinforced plastics are bonded to nonporous materials. Trapping solvent is entirely possible in reinforced plastic, which at best is usually slightly porous. Difficulty is caused when the solvent volatizes because it is subjected to elevated cure temperature. The vapor will tend to force its way through the adhesive layer and weaken the bond.

The time at which a semi-cured joint can be handled is of importance in a production shop. The sooner an assembly can be released from a curing jig, the less will be the required number of jigs to sustain a given production rate. The sooner the assembly can undergo the next production operation, the lower will be the parts inventory on the production floor. Determination of the time period after which a bonded assembly becomes handleable, and also the period for full cure, can be made either experimentally, testing assemblies at various stages of cure, or theoretically, by heat transfer considerations. These considerations should include conduction, convection, radiation, and dielectric effect as applicable.

Varying the curing time can have a marked effect upon joint strength. For one particular joint, in which Redux—which is phenolic and polyvinyl formal—was used to bond Alclad lap joints under identical cure temperatures, best strengths were obtained with shorter cures (*6*). This applies when tests were conducted at room temperature. But when the strength tests were performed at 212° F., the shorter cures gave the poorest results. Just a slight increase in the curing time, however, caused a significant rise in the elevated temperature strength.

The standard cure before this investigation was twenty to thirty minutes, giving a failing load of 2200 pounds at room temperature and only 1400 pounds at 212°F. A curing time of sixteen hours gave failing loads of about 2000 pounds for both room and elevated temperature tests. A curing time increase from one-half to sixteen hours resulted in only a ten per cent loss in room-temperature strength but a 230 per cent strength

gain at 212°F. The rate of change of strength at less than two hours cure was so great that the normal cure-time variation in a production shop would produce a large scatter in joint strengths.

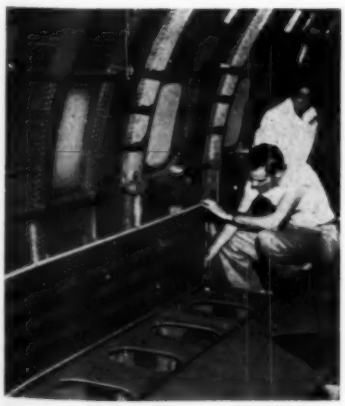
Other people (*7*) have cited strengths at 212°F., being more than doubled by aging 192 hours at 212°F. This same result could have been obtained by curing under pressure for only four hours.

Less strength variability usually results when longer cures are used. Not only is the average bond strength raised by a longer cure, but the deviation of strengths from the average is reduced. This means greater reliability and the need for less of a safety factor in joint design.

Not Always Applicable

It should be borne in mind that these trends do not necessarily apply to all adhesives used with reinforced plastics. Prolonged curing may also cause greater adhesive brittleness. Examples have been presented only to illustrate how cure time variations can affect strengths. Adhesives manufacturers should be consulted about behavior of their particular products.

A number of means are available for the control of the thickness of the adhesive layer in a joint. One way is to employ the adhesive in the form of a supported film which may be placed between the surfaces to be bonded. If the adhesive material remains highly viscous throughout the curing cycle then very little of it will be extruded from the joint while it is being pressed and the thickness of the adhesive will be determined by the original thickness of the film which was used in its assembly.



Bonded reinforced epoxy resin is used in Douglas aircraft to replace aluminum floor.

A second method is to use an adhesive which is inclined to flow and to be extruded under pressure, but to prevent excessive extrusion by the use of shims or stops. With this technique, the thickness of the adhesive in the joint is determined by the thickness of the shims or stops. The shims or stops may be removed after the joint is cured. Another version of this method is to design elevated lands into the joint in such fashion so as to determine the thickness of the adhesive by their raised height. The lands, of course, become a part of the structure of the joint.

A third method for determining the thickness of adhesive in a joint is to employ a thixotropic adhesive mixture of such consistency that the extrusion of adhesive from the joint under constant pressure will cease when the adhesive reaches the desired thickness. This can be accomplished by following certain rheological principles. This approach is workable only when using adhesives which maintain their thixotropic properties throughout the curing cycle.

A fourth method of determining the thickness of the adhesive is to press the joint to the desired film thickness by measurement and then to remove the pressure during the remainder of the curing cycle.

The selection of a method for controlling the thickness of adhesive in a joint is governed by the design of the joint, the consistency of the adhesive, and by the curing characteristics of the adhesive. An adhesive which shrinks significantly or which evolves gases or vapors during cure should not be cured without pressure. Adhesives having certain flow characteristics cannot be controlled except by stops or lands. Accordingly, the selection of the adhesive is dictated in part by the method to be used in controlling the adhesive thickness.

Perhaps the most important factor which determines the quality and reliability of an adhesive joint is the skill of the operator who does the work and the competence of the supervisors who train the operator and who accept or reject the finished product.

In the field of welding it has become customary to demand a certain degree of knowledge and skill before an operator is permitted to do responsible work. Usually the knowledge and skills are acquired as a result of formal training and apprenticeship. The operator is then qualified on the basis of formal examination, both written and experimental. For practice in this field the "Welding Handbook," published by the American Welding Society, can be consulted.

By comparison, much less attention has been given to the training and qualification of adhesive bonders in the reinforced plastics industry. However, there is no reason to suppose that adequate training and qualification of operators and supervisors would make it any less worthwhile in this field than it has been in the welding field.

Educating Operator

It is desirable that the operator be acquainted with the nature of the materials and processes involved and that he should have first-hand experience in making various types of joints and in breaking them before he is assigned to the assembly of products. For optimum results the trainee should read and attend lectures, should have access to a test machine and should run tests on the products of his own labors. He may then ferret out his own mistakes and obtain an understanding of the factors involved. He should then be qualified on the basis of his knowledge, his powers of observation, and his ability, to produce reliable sets of joints under factory conditions. Any less training and supervisory control can lead to unreliable reinforced plastic bonded assemblies.

Acknowledgement

The information presented in this paper has been adapted from a portion of the book "Adhesive Bonding of Reinforced Plastics," by H. A. Perry, McGraw-Hill, 1959. The book was sponsored by Owens-Corning Fiberglas Corporation.

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NEWS of the ADHESIVES WORLD

Adhesives Featured At Chemical Exposition

The growing importance of adhesives was evident at the 27th Exposition of Chemical Industries held at New York City's Coliseum from November 30 to December 4. More than 40,000 trade visitors attended the exposition to see the very latest engineering developments in equipment, instrumentation and corrosion resistant materials for the 18 chemical process industries. Of the 550 exhibits, 19 were directly sponsored by adhesives manufacturers and many others by makers of accessory laboratory and production equipment.

The exposition emphasized newly developed products and working models of ultramodern, automatized equipment able to withstand higher pressures, higher temperatures and more corrosive conditions. The Amercoat Corp., South Gate, Calif., highlighted its new catalyzed coal tar epoxy coating providing exceptional resistance to many solvents and most acid and alkali solutions. The coating has high adhesion to prepared steel or concrete surfaces. American Thermocatalytic Corp., Mineola, N.Y., featured two types of cement, an air dried type with particularly good adhesion to metals and a thermosetting variety giving high bond strength with refractories. Versatility of application was stressed by the six major adhesives displays—Allied Chemical Corp., Raybestos-Manhattan, Inc., Republic Lead Equipment Co., Scientific Glass Apparatus Co., United States Stoneware Co. and Fibercast Div., Youngstown Sheet & Tube Co.

Automation in measurement and control was exemplified by the Brookfield Engineering Laboratories display of continuous rotational viscometers. Crawford and Russell, Inc., showed a working model of a solvent polymer plant which it had designed. Remotely operated flowmeter systems were exhibited by Fischer & Porter Co., while the J. H. Day Company had a full line of its mixers in simulated operation. Morehouse-Cowles, Inc., referred to the adhesives processing applications of its high-speed, stone disc mills. The suitability of Sprout, Waldron & Co. pneumatic conveyors, reduction machines and mixing units for adhesives manufacture was stressed by the consultants at the firm's "School of Adaptioneering" booth.

Participants in the signing of the licensing agreement between Rubber & Asbestos Corp., Bloomfield, N.J., and Adhesivos Resistol, S.A., Mexico, D.F., are: Seated, left to right, Benard R. Sugerman, president of Rubber & Asbestos; Adolfo Patron, technical director of Adhesivos Resistol; Elliot H. Green, secretary-treasurer of Rubber & Asbestos; Standing, left to right, Martin M. Grover, vice-president, technical, of Rubber & Asbestos; and William A. Angus, Jr., vice-president, sales, of Rubber & Asbestos.

R&A To Operate in Mexico

Rubber & Asbestos Corp., Bloomfield, N. J., has announced the signing of an exclusive licensing agreement, covering the manufacture and distribution of a diversified group of its solvent-dispersed industrial adhesives in Mexico, with Adhesivos Resistol, S.A., Mexico, D.F. According to the company, its adhesive formulations to be manufactured in Mexico by Adhesivos Resistol include Bondmaster products for the bonding of ceramic and acoustical tiles; rigid foamed polystyrene, polyethylene film and other vapor barrier and insulating materials; tack-free flexible foam adhesives for furniture manufacture; tire retread cements; pressure sensitive adhesives; laminating, combining and flocking adhesives; and a wide range of general purpose formulations.

Schenectady Resins increase tack, help pressure-sensitive adhesives stay "*put*"

Schenectady pure terpene resins provide outstanding tack and excellent adhesion for pressure-sensitive adhesives used on surgical, electrical and masking tapes. Completely compatible with SBR, natural, reclaimed and butyl rubbers, these heat softening resins have excellent acid, alkali and oxygen resistance and extremely light color.

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Schenectady manufactures the most complete line of resins for adhesives in the industry. Phenolics, modified-phenolics, terpenes and terpene phenols all are available and in commercial use. Whatever your adhesive resin requirement, your Schenectady technical representative is ready to help. Why not call him today or write Schenectady Varnish Company, Inc., Dept. 92-1, Schenectady 1, N. Y.

SHOE SOLE ADHESIVES containing Schenectady phenolic resins have excellent cohesion and adhesion. Tack-free at room temperature toward other materials, they simplify handling, speed production.

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Goodrich Names Four

B. F. Goodrich Co., Akron, Ohio, has announced four personnel changes in its Adhesive Technical Department. Lawrence Beezley has been named section manager over process control, and will be responsible for all factory services and control work. Myron I. Wilson and Robert E. Meiser have been appointed senior development engineers, responsible for sales service and new product development. Joe R. Winney has been named senior product engineer.

Mr. Beezley received his M.S. degree in chemistry from the University of Iowa in 1941, and in 1943 joined Goodrich in its general chemistry laboratory. He later served in factory service and processing and joined the Adhesives Department in 1947. Mr. Wilson received his M.S. degree in chemical engineering from Ohio State University in 1948, and then joined Goodrich as a materials engineer in the general chemical laboratories. He then joined the Adhesives Department where he has worked in development, manufacturing and sales service.

Mr. Meiser graduated from Purdue University in 1939 with a chemical engineering degree, and joined Goodrich the same year. He started work in the general testing laboratories, later serving in raw materials, processing and tire compounding. He joined the Reclaim Technical Department in 1943, and later moved to reclaim sales where he became manager in 1952. Mr. Winney received his chemistry degree from Kent State University in 1950. He joined Goodrich in 1951, starting as a laboratory technician. In 1952 he joined the general chemical laboratory as a materials engineer. He has been in the Adhesives Department since 1956 and has contributed to several important projects.

To Promote Caulking

Thiokol Chemical Corp., Trenton, N. J., has announced the launching of a new national advertising, promotion and information program, designed to acquaint the boating industry and individual boat owners with the properties and advantages of caulking compounds based on polysulfide liquid polymers. The company reports that the campaign, aimed at builders, yard owners and boat owners, will use consumer and trade advertising, point-of-sale material and public relations.

James A. Collins

Named By Houghton

James A. Collins, formerly with Batten, Barton, Durstine and Osborn, Inc., has been appointed advertising and sales promotion manager of Houghton Laboratories, Inc., Olean, N.Y. Mr. Collins attended Cornell University, and has been a sales promotion specialist for the past 13 years. Since 1957, he has acted as a consultant to many national companies and advertising agencies in regard to their sales promotion problems. Mr. Collins has directed projects for Junior Achievement of New York, Cleveland (Ohio) Community Chest, and the Cleveland Advertising Club. He is a member of the Sales Promotion Executives Association of New York.

Exhibiting At Show

Potdevin Machine Co., Teterboro, N. J., has announced that it will exhibit gluing and coating machinery for bag making production, label pasting, laminating and binding operations at the AMA National Packaging Show on April 4 to 7 in Atlantic City, N. J. The company reports that highlighting the exhibit will be its new Model SE Hot Melt Seam Extruder, an attachment to web machines that permits high speed production use of solid adhesives. According to Potdevin, it will also show a number of gluing, edge coating and label pasting machines. These include its Type Z 27-inch gluing machine; LM 6-inch Label Paster with semi-automatic feed; MG 4-inch Ductor Roller Margin Gluer; 2R 12-inch coating machine; LA 6-inch label activator; Topside Margin Gluer; and the Rawson semi-automatic labeler.

Chemists Hold Meeting

The Congress of the International Union of Leather Chemists' Societies devoted a full day to the discussion of "Collagen" during its recent meeting at Munich, Germany. The session was held in view of the fact that the leather industry is one of the chief suppliers of raw materials for the gelatin and glue industries and that leather manufacturers must cope with the same scientific problems, such as collagen. Six papers were presented during the one-day session. They were: "The Tropocollagen Macromolecule," by Prof. F. O. Schmitt (M.I.T.); "On the Origin of the Various Cross-Striation Patterns of Collagen," by Dr. K. Kuhn (Technische Hochschule, Munich); "Chemical Studies about the Arrangement of Carbohydrates of Collagen," by Dr. H. Hormann (Max Planck Institute, Munich); "Structural Relationship Between Collagen and Gelatin," Prof. A. D. Ward (British Gelatin and Glue Research Association, London); "Structural Changes in Collagen Induced by Alkalis," by A. Courts (British Gelatin and Glue Research Association, London); and "Dynamic Electrical Behavior of Untanned Hide Containing Sorbed Water," by L. P. Witnauer (Eastern Regional Research Laboratories, Philadelphia).

Borden Splits Stock

The Borden Co., New York, N.Y., reports that its stockholders have voted in favor of a two-for-one split of the company's capital stock. The stock split became effective at the close of business January 5, 1960, and stockholders of that record date were mailed certificates for additional shares on January 27. According to the company, 77 per cent of its shares were voted and the vote was 99.64 per cent in favor of the split.

Roberts Names Two

The Roberts Co., City of Industry, Calif., has named two new distributors to handle its line of Anchor-Weld adhesives. Vulcan Equipment & Supply Co., Shreveport, La., will distribute Anchor-Weld adhesives in a territory covering a radius of approximately 150 miles from Shreveport. The second new distributor, Building Products Co., Jackson, Miss., will cover a territory within a 150 mile radius of Jackson.

Adds To Overseas Repackaging Set-Up

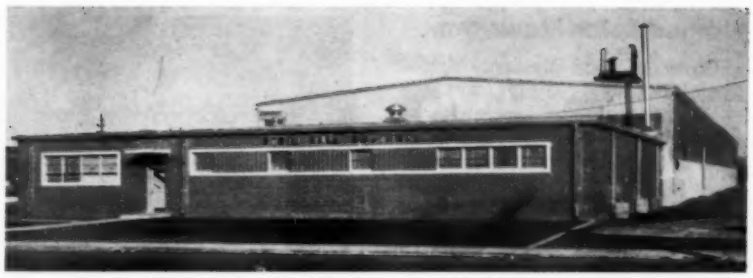
Miracle Adhesives Corp., Bellmore, N. Y.; has announced that it recently concluded repackaging agreements with Wise & Co., Manila, P. I., and Gazitua Bindhoff & Co., Ltd., Santiago, Chile. In line with previously established overseas repackaging arrangements involving companies in Mexico and Switzerland, Wise and Gazitua Bindhoff have undertaken to import from the United States, Miracle adhesive and insulation compounds in bulk for repackaging in the Philippines and Chile. The company also reports that actual manufacture of Miracle products in Spain under special license will soon be initiated by Productos Carlen, Madrid, Spain. Miracle products manufactured in Mexico and Switzerland have sold very successfully against competitive products, the company states.

According to the company, Miracle adhesives are used for setting clay tile and these tile installations have proven themselves in subways, tunnels, highways, office buildings, schools and other projects all over the world. In addition, Miracle adhesives are widely used for mounting wallboard and gypsum board for duct insulation and for sealing and caulking applications, the company states. Miracle Anchor adhesives used with Miracle Surface Anchors are widely used to speed installation of insulation, quickly and surely bonding block insulation to ducts, walls and ceilings.

Sales and Earnings Up

Borden Co., New York, N.Y., reports that its sales and earnings for the third quarter and the first nine months of 1959 were at an all-time high. The 1959 third quarter sales were $241,606,664, up 4.4 per cent from the $231,376,016 of the 1958 third quarter. Earnings were $7,100,678, up 2.2 per cent from the year earlier $6,949,844 figure. Third quarter earnings per share were $1.44, compared with $1.43 for the like 1958 period.

Sales for the first nine months of 1959 were $698,059,820, up 2.5 per cent from the $680,964,070 for the like period of 1958. Nine-month earnings totaled $19,033,584, up 4.5 per cent from the $18,212,882 figure for 1958. Earnings per share equaled $3.87 for the nine-month period, compared with $3.74 earned during the same 1958 period.



Stein Hall Dedicates Subsidiary

Stein Hall & Co., New York, N. Y., dedicated a new subsidiary, Stein Hall Southern Inc., in Charleston, S. C., on November 20, 1959. The dedication ceremonies were attended by South Carolina civic and government leaders and included key men from textile, paper manufacturing and food processing industries for whom Stein Hall Southern is designed to be a prime supplier of commodities. General Mark W. Clark (USA-Ret.), president of The Citadel, headed the committee which welcomed the company to its new $800,000 plant and warehouse.

According to Stein Hall, the plant will process guar, a gum extracted from the seed of the guar plant which grows in India and Pakistan. Stein Hall Southern also will produce starch products as well as modified tapiocas and galactomannan gums, the company states. Harry Vogel, formerly assistant plant manager of another Stein Hall subsidiary, the Stein-Davies Co., Long Island City, N. Y., has been named manager of the new Charleston plant. Stein Hall Southern is Stein Hall's fifth subsidiary and seventh manufacturing plant.

Sammon Named President

Stein, Hall & Co., Inc., New York, N.Y., has announced that Roger B. Sammon has been elected president of its Canadian subsidiary, Stein, Hall Ltd., Toronto, Ontario, Canada. Mr. Sammon, previously vice-president, succeeds David McGill, who has been named chairman of the board of directors of the subsidiary. The company also announced that Robert Strasser has been appointed executive vice-president of the Canadian firm.

Mr. Sammon graduated from the Columbia College School of Business in 1948 and then joined Stein, Hall's New York offices as a clerk in the Foreign Division. In 1949, Mr. Sammon was transferred to Canada to serve as assistant to Mr. McGill. He was elected a vice-president of Stein, Hall Ltd., in 1952 and a director of the company in 1955. Mr. Sammon is a director of the Packaging Institute of Canada.

Completing New Addition

Mystik Adhesive Products, Inc., Chicago, Ill., has announced that the new addition to its manufacturing plant facilities at Northfield, Ill., is nearing completion. According to the company, the new plant has over 100,000 square feet of manufacturing area and will be fully automated in its manufacturing and quality control processes.

Two Join W. R. Grace

Dr. Robert E. Gilman and Dr. Wendell C. Overhults have joined the Research Division of W. R. Grace & Co., New York, N. Y. A 1954 graduate of Dartmouth College, Dr. Gilman received his Ph.D. from the University of Michigan in 1958. He will be engaged in organic research at the Washington Research Center in Clarksville, Md. Dr. Overhults was previously engaged in the synthesis of propellants and explosives at the Aberdeen Proving Grounds, and earlier he conducted research on linear and stereospecific polymers at Battelle Memorial Institute. In his new capacity, he will conduct research on new polymers. A 1943 graduate of the University of Colorado, Dr. Overhults received his M. A. from the same University and his Ph.D. from Iowa State College in 1954. Both men are members of the American Chemical Society.

Named Sales Manager

Durez Plastic Division, Hooker Chemical Corp., North Tonawanda, N.Y., has appointed Henry B. Puff as manager, field sales. The company also announced that Richard W. More has been named to succeed Mr. Puff as assistant product manager, resins, and Ross S. Tanner has been appointed to the newly created post of division controller. Mr. Puff joined Durez as a chemist in 1946 after graduating from Bucknell University with a B.S. degree in chemistry. In 1947, he transferred to the Sales Department, working out of the Chicago office. He was named Chicago district sales manager in 1956, and in early 1959, he returned to North Tonawanda as assistant product manager, resins. Mr. Puff is a member of the Forest Products Research Society, the Society of the Plastics Industry, the American Foundrymen's Society, the Rubber Division, ACS, and the American Society for Testing Materials.

Mr. More was graduated from Harvard University with a B.S. degree in chemistry in 1947, coming to Durez the same year as a chemist. From 1948 to 1956 he was a resins sales representative, and subsequently was in sales engineering. He is a member of the Forest Products Research Society. Mr. Tanner has a B.S. degree in accounting from Syracuse University. He joined Durez in 1957 and had been accounting supervisor until 1959, when he was named chief accountant of the division.

Henry B. Puff

Checking Glued Lumber

The American Institute of Timber Construction, San Francisco, Calif., has announced a plan for checking each step in the manufacture of glued laminated members and fabrication and assembly of timber beams and arches. The checking program, which was in the planning and development stage for over two years, will apply to engineered timber construction, both glued laminated as well as sawn. According to the institute, the program will cover materials, workmanship, tolerances, structural and appearance grades, standard sizes, tests, inspection and reinspection, and product identification.

Completes Resins Plant

National Polychemicals, Inc., Wilmington, Mass., has completed construction of a new plant in Conway, N.C., to produce phenol and urea formaldehyde resins. The company reports that the plant is expected to be in operation early in 1960, and initially will produce resins for the woodworking, paper and textile industries, as well as other industrial outlets in the South.

Develops Vapor Barriers

American Sisalkraft Corp., Attleboro, Mass., has announced the development of a family of fireproof vapor barriers which are expected to find use in the building, construction, heating, ventilating and associated fields. The company reports that the first of this new group of barriers consists of aluminum foil and kraft paper bonded together with a flame extinguishing adhesive and reinforced with fiber glass strands. According to American Sisalkraft, this basic kraft to foil Pyro-Kure can be supplied with various weights of paper, thickness of foil, and amounts of reinforcement, and also in foil-to-embossed kraft, either black or white, and in foil to foil barriers. The company claims that the advantages of these new materials are: flame resistance; vapor proof characteristics; strength and durability; low cost; and attractive appearance. The adhesive in these barriers is non-corrosive, non-toxic, non-leaching, and stable, the company states. Applications are expected to be as insulation facings for lining of pipes and ducts, and for general barrier usage in commercial and industrial construction.

PMMI Show Features Adhesives

The 1959 Packaging Machinery Manufacturers Show was held at the New York Coliseum, New York, N.Y., November 17-20, 1959. Approximately 20,000 members of the packaging and related industries visited the more than 150 displays that made up the mammoth exhibit. The public was not admitted and attendance was by industry invitation only.

Held in conjunction with the PMMI Show was the 21st Annual National Packaging Forum of the Packaging Institute. Sessions were held at the Statler-Hilton Hotel, November 16, 17 and 18. This year's forum selected as its theme "Industry's Launching Site for Projecting Packaging Progress."

Displays at the Coliseum included the latest in equipment and machinery for the packaging industry. National Starch and Chemical Corp., for example, featured both dielectric sealing and extrusion of granular hot melts in a demonstration of advanced techniques for packaging. Attention was focused on a recently perfected hot melt extruder supplied by Potdevin Machine Co., Teterboro, N.J.

According to National Starch, the extruder is superior to other hot melt application techniques because it is a closed system and prevents adhesive degradation. The latter is thought to occur when molten adhesive is exposed to air for long periods of time in pre-melt tanks or heated glue pots on the production line.

Cord-Like Adhesive

At the booth of the United Shoe Machinery Corp., Boston 7, Mass., demonstrations were given of seven different applicators that use a cord-like adhesive known as Thermogrip. The applicator melts, meters and applies the adhesive in the proper consistency and design to the passing objects or material.

Unveiled at the show, was the latest type of applicator, the Model DN. Although designed for multi-wall bag closing, the equipment is adaptable to many other uses where continuous lines of adhesive are wanted.

As a special convenience for obtaining additional information from exhibitors, visitors to the show were given a plastic address plate similar to those used for charge account cards. Each exhibitor had an imprint machine which enabled him to make an accurate record of the visitor's address in only a few seconds.

Pesek Elected Director

C. P. Pesek, vice-president for engineering and staff manufacturing, Minnesota Mining & Manufacturing Co., St. Paul, Minn., has been elected to the 3M board of directors and to the firm's executive committee. Mr. Pesek graduated from the University of Minnesota and engaged in private practice as an architect and engineer for several years before becoming a partner in the firm of Pesek and Shifflet in 1931. He joined 3M in 1944 as chief industrial engineer, becoming administrator of engineering in 1945 and vice-president for engineering in 1947. While serving as vice-president for engineering and staff manufacturing, Mr. Pesek directed the vast program required to keep 3M facilities abreast of its post-war growth. During World War II, he served with the U. S. Army Engineers, being one of the principal engineers during the construction of the Gopher Ordnance Works at Rosemount, Minn.

Using More Laminations

Fred Stevens, product manager of American Sisalkraft Corp., Attleboro, Mass., reports that within the next few years the use of plastic laminates and coatings—plastics bonded to metal, paper, or other materials, or applied as coatings to existing products—will supplement and in many cases supplant all-plastic materials used in the manufacture of products ranging from toys to appliances. In predicting this trend, Mr. Stevens points out that bonding of plastics to kraft and to metal foil, or of kraft to foil, often results in a material having the desirable properties of both and the limitations of neither. Since the cost of laminated and coated products is competitive with conventional materials, their improved properties will make them especially attractive to the construction industry, Mr. Stevens states.

Holding Conference

The Society of Plastics Engineers will hold its annual regional technical conference on April 20 at the Hotel Texas in Fort Worth, Texas. The North Texas Section of SPE is sponsoring the meeting which will have as its theme, "Plastics in the Petroleum and Chemical Industries." The program will offer two concurrent sessions with papers on surface coatings and plastics structures.

Synkoloid Buys Gelvatex

Shawinigan Resins Corp., Springfield, Mass., has announced that its division, Gelvatex Coatings of Anaheim, Calif., has been purchased by the Synkoloid Co., Inc., Los Angeles, Calif. According to Shawinigan, Synkoloid has acquired the entire physical plant of the Gelvatex organization including all production equipment and research facilities. Synkoloid, a major producer of water base emulsion paints and water base specialty items, will manufacture a complete line of water base paints including all Gelvatex products at the Anaheim factory. Synkoloid, which recently opened a plant in Paterson, N. J., also maintains manufacturing facilities and sales offices in Los Angeles, Seattle, Vancouver, B. C., Dallas, and Miami, Fla.

Staley Reports Profit

A. E. Staley Manufacturing Co., Decatur, Ill., has reported a net profit of $5,712,982 for the fiscal year ended September 30, compared with a net profit of $5,881,267 for the previous fiscal year. Staley acquired the U B S Chemical Co., Cambridge, Mass., on June 30, 1959, and the report figures are on a consolidated basis, with year-ago figures adjusted for comparison. Net sales for the fiscal year reached a new high of $168,704,309 in comparison with net sales of $161,468,002 for the preceding year. Earnings per share of common stock for the year were $2.74 compared with $2.91 in the prior year.

"I've found another application for adhesive formula 79306—skin to counter top."

GIA Elects Officers

The Gummed Industries Association, Inc., New York, N. Y., elected new officers for 1960 at its recent annual meeting at White Sulphur Springs, West Va. The association also approved of plans for an intensive, long-range industry merchandising program, with initial emphasis to be placed on market research and public relations. Stuart E. Thompson (Central Paper Co.) was elected president of GIA, and Saul Warshaw (Atlantic Gummed Paper Corp.) was elected vice-president. Phillip O. Deitsch was re-elected secretary, treasurer and managing director of the association. He has been managing director for 22 years.

Newly elected directors are: R. T. Meyer (Tape, Inc.); E. W. Acton (Thomas Stationery Mfg. Co.); and David Mazer (Hudson Pulp & Paper Corp.). Directors who were re-elected are: W. G. Bretson (Minnesota Mining); Stanley Greenblath (Superior Tape Corp.); A. J. Thiel (Ludlow Papers, Inc.); and E. F. Herrlinger II (Gummed Products Co.).

Develops Nalcoag 1050

Nalco Chemical Co., Chicago, Ill., has announced the commercial availability of a 50 per cent concentrate of silica sol containing 49 to 50 silica by weight. Called Nalcoag 1050, the concentrate is an aqueous colloidal suspension of silica. According to the company, Nalcoag 1050 can be used as a surface treatment agent in a broad range of products, because it forms an unusually strong bond. The infinitesimal size of the particles enables them to fill in minute pores of solid surfaces, and, as a result, there is a tendency to increase friction, and improve soil resistance and film strength, the company states.

PVC Plant On Stream

Plicoflex, Inc., Houston, Texas, has announced that its PVC compounding and calendering plant in Houston has gone into full production. The plant, with about 40,000 square feet of space, is producing corrosion resistant pipeline wrapping tapes. The tape, made of laminated polyvinyl chloride film and butyl rubber with flame resistant and fungus resistant additives is designed to give complete protection under ground or under water, the company states.

BRI To Hold Conference

The Building Research Institute, Washington, D.C. will hold its Spring Conferences on April 5 to 7 at the Statler-Hilton Hotel in New York, N.Y. The BRI reports that program details and speakers are being rounded into shape and the following subjects have been approved by its Programs Committee: "Use of Adhesives for Bonding Wallboard and Cementitious Material and for Wood Structural Lamination," Chairman, George Schulte (Minnesota Mining); "Surface Preparation and Field Application of Paints and Coatings," Chairman, Harry R. Young (DuPont); "Operation and Maintenance Costs on Four Types of Buildings," Chairman, Howard E. Phillips (American Tel & Tel); "Reports on College and University Building Research Projects," Chairman, Harold D. Hauf (Rensselaer Polytechnic); "Proposals for New Building Research," Chairman, James Lendrum (University of Florida); "Plastics Information Workshop," Chairman, William F. Reardon (General Electric); and "Insulated Masonry Cavity Wall."

Fuller Names Three

H. B. Fuller Co., St. Paul, Minn., has announced three executive promotions which are reported to be related to a gradual shift of the company into a vertical integration by product lines. E. A. Vigard, vice-president and general manager of H. B. Fuller Minnesota Co., has been named vice-president of the Adhesives Division of the parent H. B. Fuller Co. George L. Ryberg, previously vice-president and general manager of H. B. Fuller Company of Missouri, succeeds Mr. Vigard as vice-president and general manager of the Minnesota company. R. E. Foley has been named vice-president and general manager of the Missouri Fuller company, succeeding Mr. Ryberg.

Officers Re-Elected

The Society of the Plastics Industry, New York, N. Y., reports that its Epoxy Resin Formulators Division has re-elected its officers to serve for another year. The division officers are: *Chairman,* L. R. Miller (Rozolin, Inc.); *First Vice-Chairman,* John Delmonte (Furane Plastics); and *Second Vice-Chairman,* Donald Roon (Houghton Laboratories, Inc.).

August Napravnik

Named Vice-President

Catalin Corporation of America, New York, N.Y., has announced that August Napravnik has been named vice-president in charge of production. Mr. Napravnik holds a B.S. degree in chemical engineering and an M.S. degree in chemistry from Lehigh University. He joined Catalin in 1939, and has served as head of the New Products Division and production manager. He was instrumental in the establishment of the firm's Chemical Division. Mr. Napravnik is a member of the American Chemical Society, Chemical Market Research Association, Commercial Chemical Development Association, and The Society of Plastics Engineers.

3M Building Office Site

Minnesota Mining & Manufacturing Co., St. Paul, Minn., has announced plans for the construction of a $10 million, 14-story administration building at its research center located east of St. Paul. According to the company, site preparation has begun and the building is expected to be completed early in 1962. A two-story cafeteria building and an underground ramp garage also will be built, the company states. The company reports that the new buildings are urgently needed to meet immediately foreseeable demands for office space, and these buildings are a major step in the development of a combined research and administrative headquarters in pace with 3M growth. The building site, a 265-acre tract, is planned to accommodate all the research and administrative facilities which present sales forecasts indicate 3M will need through the late 1960's or early 1970's, the company states.

Plastics Production Up

The Society of the Plastics Industry, Inc., New York, N. Y., states that plastics production was up 25 per cent in 1959 to an estimated 5,600,000,000 pounds of raw materials, compared with 4,518,000,000 pounds in 1958. As part of a four-page report on 1959 plastics production, SPI states that the 1959 value of plastics products was approximately $3 billion compared with $2.5 billion in 1958. In each of the last seven years the plastics industry has made a new record, but 1959's 25 per cent increase over 1958 far exceeds the original expectations of 10 per cent, the society remarks. According to SPI, on top of this large increase of last year, the industry has indicated that it plans to expand 25 per cent in 1960. However, SPI estimates that production for 1960 will be up approximately 15 per cent, as it takes time to bring into being this additional expansion.

Nuodex Names Schaeffer

Nuodex Products Co., Elizabeth, N.J., a division of Heyden Newport Chemical Corp., has announced that Leonard Schaeffer has joined the company as chief of its Protective Coatings Laboratory. Mr. Schaeffer is a graduate of the Polytechnic Institute of Brooklyn with a B.S. degree in chemistry. He has a background of over 20 years in the paint industry and his most recent association was as technical director of the M. J. Merkin Paint Co. Mr. Schaeffer is secretary of the Technical Committee of the New York Paint and Varnish Production Club and chairman of its Subcommittee 40, concerned with hiding power.

Holding Exposition

Interpack, the second International Trade Fair for Packaging Machines, Confectionary Machines, and Packaging Materials, will be held on April 20 to 27 at the Exhibition Grounds in Duesseldorf, Germany. Participating in the exhibition will be 420 firms, including 120 from foreign countries. Seven United States firms, including German representatives, have applied for participation. Exhibits will include filling, wrapping and labelling machines, and space will be devoted to packaging materials. The Congress of the European Packaging Federation will be held concurrently with the fair.

Makes Year-End Remarks

Henry H. Reichhold, president and general manager of Reichhold Chemicals, Inc., White Plains, N. Y., states in a year-end statement that the chemical industry must accelerate its building of new plants and produce larger quantities of plastics at lower prices if it is successfully to capture a bigger share of the potential market from the producers of steel, natural fibers, rubber and concrete. Mr. Reichhold urges that the industry not sit back and rely on current production but wisely plan for the foreseeable increase in demand in the future. The future of the industry rests in its ability to keep pace with the growing demand brought about by the development of wider uses of plastics, he says. Mr. Reichhold states that RCI's contribution to the growth of the chemical industry can best be illustrated by its construction and expansion program during 1959. This includes new construction of a $4 million maleic plant and a $5 million phthalic plant at Elizabeth, N. J.; and a multi-million dollar phenol plant in Tacoma, Wash.

Amoco Building Plant

Amoco Chemicals Corp., Chicago, Ill., is building a semi-commercial plant near Joliet, Ill., to make trimellitic anhydride in multimillion-pound quantities. Amoco reports that the material can be used to make coatings, resins and adhesives. According to the company, trimellitic anhydride is the first of a series of new aromatic acids to be made by its oxidation process. Some of these acids will be introduced in pilot plant quantities later this year, the company states.

Fiero Named President

The Chemical Specialties Manufacturers Association, Washington, D.C., has announced that Dr. George W. Fiero (Esso Standard Oil Co.), has been named president of the association. Since 1945, Dr. Fiero has served the association as chairman of several committees, chairman of its Insecticide Division and a member of the board of governors. He was second vice-president in 1958, and first vice-president in 1959.

Begins Production

Borden Chemical Co., New York, N.Y., reports that its has begun initial production of acrylic emulsions in its new manufacturing plant at Demopolis, Ala. The new unit, Borden's first in the South, will add substantially to the company's existing production capacity for these products, the company states. Borden also operates similar manufacturing facilities at Leominster, Mass., Illiopolis, Ill., and Compton, Calif.

The company also announced that it has completed construction of a $500,000 plant in Illiopolis, Ill., for use by its Coatings and Adhesives Department. Occupying 24,000 square feet of floor space, the new plant provides facilities for general manufacturing, warehousing, solvent processing, offices, and a tank farm, the company states.

Opens Midwest Office

Rubber & Asbestos Corp., Bloomfield, N.J., has announced the opening of a Midwest sales office. The new office is located at 3553 West Peterson Avenue, Chicago 45, Ill.

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Feb. 2-4. 15th Reinforced Plastics Division Conference, Society of the Plastics Industry, Edgewater Beach Hotel, Chicago, Ill.

Feb. 4-6. American Society for Metals Conference, Fairmount Hotel, San Francisco, Calif.

Feb. 5-7. Fourth Annual Home Improvement Products Show, Navy Pier, Chicago, Ill.

Feb. 8-10. Fifth Joint Military-Industry Packaging & Materials Handling Symposium, Sheraton Park Hotel, Washington, D.C.

Feb. 14-18. Hobby Industry Association, American Trade Show & Convention, Sherman Hotel, Chicago, Ill.

Feb. 15-17. ASTM Committee D-1 on Paint, Varnish, Lacquer, and Related Products, Shoreham Hotel, Washington, D.C.

Feb. 18-19. Chemical Institute of Canada, Divisional Conference on Protective Coatings, Toronto, Ontario, Canada

Feb. 20-22. National Home Improvement Show, New York Coliseum, New York, N.Y.

Feb. 21-24. American Institute of Chemical Engineers, National Meeting, Biltmore Hotel, Atlanta, Ga.

Feb. 22-25. TAPPI 45th Annual Meeting, Hotel Commodore, New York, N.Y.

Mar. 6-10. Toy and Merchandise Fair, Trade Show Building, New York, N.Y.

Mar. 10-11. Southern Forestry Conference, Annual Meeting, Jacksonville, Fla.

Mar. 9-11. Instrument Society of America, Temperature Measurement Symposium, Deshler-Hilton Hotel, Columbus, Ohio

Mar. 14-18. National Association of Corrosion Engineers, National Meeting, Dallas, Texas.

Mar. 22-23. Folding Paper Box Association of America, Annual Meeting, Ambassador Hotel, Los Angeles, Calif.

April 6-9. Society of the Plastics Industry, Western Section Annual Conference, Hotel Riviera, Palm Springs, Calif.

April 24-May 3. German Industries Fair, Hanover, West Germany

April 25-26. American Society of Mechanical Engineers, Maintenance and Plant Engineering Conference, Chase and Park Plaza Hotels, St. Louis, Mo.

May 20-31. International Plastics Exhibition, Oslow, Norway

May 23-25. TAPPI 11th Coating Conference, Edgewater Beach Hotel, Chicago, Ill.

May 23-26. American Society of Mechanical Engineers, Design Engineering Conference & Show, Statler Hilton Hotel, New York, N.Y.

June 1-10. International Chemical Exhibition, Belgrade, Yugoslavia

June 5-9. Forests Products Research Society, 14th National Meeting, Montreal, Quebec, Canada

June 10-26. Federation of British Industries Exhibition, New York Coliseum, New York, N.Y.

June 13-15. 43rd Annual Conference and Exhibition of the Chemical Institute of Canada, Chateau Laurier Hotel, Ottawa, Ontario, Canada

Portrait Of

MICHAEL J. BODNAR

Chief of the Adhesives Unit of the Plastics and Adhesives Research Section at Picatinny Arsenal, Dover, N.J., Michael J. Bodnar heads one of the most active adhesive research groups in the country. Some of the problems undertaken by his group include:

(1) Bonding rare and unusual metals such as uranium 238, beryllium, rhenium, columbium, gold, silver and tantalum.

(2) Studying the effect of varying the molecular structure of epoxy resins on their mechanical strength properties.

(3) Investigating novolac-based epoxies as high temperature resistant adhesives.

(4) Bonding high explosives to metals and to themselves.

Mr. Bodnar received his B.S. in chemistry from Carnegie Institute of Technology and studied polymer chemistry at Stevens Institute of Technology. After three years with the Research Divison of Koppers Co., Inc., he joined the Douglas Aircraft Co. where he worked on adhesives problems encountered in production. He has been with the Picatinny Arsenal since 1954.

Frequently called upon by governmental agencies as a consultant on adhesives bonding problems, Mr. Bodnar is also an active member of the ASTM D-14 Committee on Adhesives. He has published several papers on adhesive and related subjects. on adhesives and related industrial subjects.

Epoxy Production Method

A new method for the production of epoxy ester coatings was featured by Union Carbide Plastics Co., New York, N.Y., at the Paint Industries Show on October 20 to 24, 1959, in Atlantic City, N.J. According to the company, using only a liquid epoxy, EDL-2774, bisphenol A and any drying acid, the formulator now can prepare, in two simple steps, a varnish with preselected properties. Basis for the new technique is the preferential reaction of the epoxy group with carboxyl groups before reacting with aromatic hydroxyl groups in a mixture where all three are present. By proper proportioning, ERL-2774, bisphenol A and a fatty acid can be reacted to produce an essentially linear epoxy of any desired chain length, terminated at each end by a fatty acid group, and this intermediate compound is then further reacted with fatty acids to produce the desired degree of esterification, according to the company's technical literature.

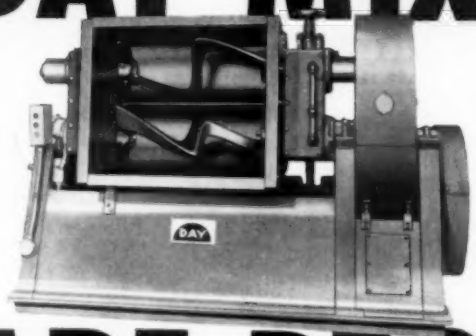
Building Exposition

Clapp & Poliak, New York, N. Y., has announced that 50 companies and organizations contracted for space at the first Industrial Building Exposition & Congress held on December 12 to 15, 1959, at the New York Coliseum in New York City. Clapp & Poliak reports that the exhibits fell into eight major categories. These included structural products, such as foundations, floors, walls, and windows; mechanical products and systems for operating efficiency, such as conveyors, elevators, and waste-disposal systems; electrical, such as power distribution, lighting, and process control; heating and air conditioning equipment; employee services; plant sites and services offered by states and municipalities, transportation, power, and water; financial services; and auxiliary services, such as landscaping and parking.

Reichhold Sells Plant

Reichhold Chemicals, Inc., White Plains, N.Y., has sold the Lindsay, Ontario, Canada, plant of its Varcum Chemical Division to Reichhold Chemicals, Ltd., of Canada. The plant, which produces phenolic molding compounds, will now obtain its resins from RCI's plant at Ste. Therese de Blainville, Quebec. The resins formerly came from Varcum's plant in Niagara Falls, N.Y.

DAY MIXERS



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names in the news

G. M. Halsey has been named vice-president of the newly consolidated Chemical Division of The Glidden Co.

James M. Shakelford has been elected treasurer of Johns-Manville Corp., succeeding **Joseph L. Wood**, who has retired.

Peter E. Macy has been appointed derivatives sales representative for Armour Industrial Chemical Co.

William A. Jarvey has been named product manager of the Vinyl Plasticizer Department of Archer-Daniels-Midland.

David E. Cordier, previously with Carwin Polymer Products Co., has been appointed technical director of Mesa Plastics Co.

Dr. Rush F. McLeary has been elected to the newly created post of vice-president for reasearch and development of Jefferson Chemical Co.

Roger E. Varin, formerly with Lehn & Fink Products Corp., has been named vice-president of the Overseas Division of Archer-Daniels-Midland.

Ellis Lehman is now technical sales representative for A.E. Staley Mfg. Co.

W. T. Parry, previously with Hercules Powder (Canada), has joined National Adhesives (Canada) as a technical sales representative.

John Orsulak has joined the research laboratories of Flintkote Co.

Louis Rey, Jr., formerly with Monsanto (Canada) has joined Shawinigan Chemicals (Canada) as a research chemist.

Dr. Edward J. Longosz has joined Esso Research & Engineering Co., as a research chemist.

William M. Land, Jr., formerly with Surprenant Mfg. Co., has joined Shell Development Co., as an engineer in chemical process engineering.

Dr. Ramsis Gobran has joined the polymer research group of Minnesota Mining & Mfg. Co.

Dr. Paul Feng, supervisor of chemical-physics research at Armour Research Foundation, has been named to the Chinese Advisory Committee on Cultural Relations in America.

Robert C. Witt has been named by Dow Chemical Co. as product manager for the sale of latices to the paint industry and of coatings materials for building products.

W. J. Bader has been promoted to the post of sales manager of the Packaging Division of The Dobeckmun Co., and **W. H. Troph** has been named sales manager for laminated and extruded products.

William V. Vins, previously with Industrial Adhesives, Ltd. (Canada), has joined Bonded Fibers, Inc., in charge of new product development in the vinyl field.

Richard E. Elden has been appointed resident manager of the Vancouver Wash., plant of Becco Chemical Division, Food Machinery & Chemical Corp. **Richard F. Braun** succeeds Mr. Elden as production manager.

Marshall E. Doyle has been named research supervisor at the research center of Shell Development Co.

James P. Casey, formerly with A.E. Staley Mfg. Co., has joined Union Starch & Refining Co., as director of starch sales.

Duane H. Eckdahl has joined the Organic Chemicals Department of Food Machinery & Chemical Corp., as administrative assistant to the department manager.

George A. T. Moore has been appointed administrative sales assistant of paper sales for A.E. Staley Mfg. Co.

Donald G. Patterson has been named vice-president, plastic, for Reichhold Chemicals, Inc.

John M. Fox has been appointed to the newly-created post of director of manufacturing of Black & Decker Mfg. Co., and **Thomas M. Griffith** has been named to the new post of director of quality control for the company.

Borden Names Two

Borden Chemical Co., New York, N.Y. has announced that Maurice S. Letourneau, New York district sales manager, has been promoted to Eastern district sales manager, and Bruce C. Duncan has been appointed a plywood sales service representative. In his new position, Mr. Letourneau will be responsible for directing the sale of Borden's full line of polymers for the textile, paper, paint and adhesives industries in the New England, New York, Philadelphia and Southern market areas. Mr. Duncan will be responsible for the sale of the company's full line of industrial wood adhesives in the state of Washington.

A graduate of the Institute of Textiles and Technology, Mr. Letourneau joined Borden Chemical in 1956 as a technical sales representative in New England. Prior to his appointment as sales manager for the New York district, he covered an area encompassing South Carolina and Virginia. Mr. Duncan graduated from the University of Washington in 1942 with a B.S. degree in forest products. For the past 16 years he has specialized in the wood and allied timber fields, including work with the U.S. Army Corps of Engineers.

James F. Knight, Jr., has been appointed a research chemist at the Adhesives Department of Amchem Products, Inc.

William A. Gallup has been named senior research chemist in the Plastics Division of Diamond Alkali Co.

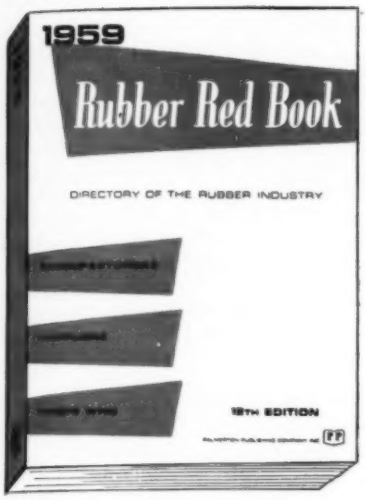
Irwin C. Gross and **John R. Hanna** have joined the Central Research Laboratories staff of Armour & Co.

Dr. Donald M. Preiss and **John W. Goodenbour** have been added to the staff of the Emeryville Research Center of Shell Development Co.

Robert D. Scarlett has been named director of foreign development at Minnesota Mining & Mfg. Co.

Leonard J. Wood has been appointed product manager of the Paper Division of National Starch & Chemical Corp.

Dr. Louis E. Wise, of the Institute of Paper Chemistry, has been named to receive the 1960 medal of the Technical Association of the Pulp and Paper Industry.



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patent review

By MELVIN NORD

Apparatus for Applying Adhesive to Wood Veneer

U. S. Patent 2,899,927, issued Aug. 18, 1959 to Thomas H. Prentice, describes an apparatus for distributing a film or coat of adhesive upon the faces of wood veneer sheets.

It has been found that a well-distributed, completely satisfactory adhesive film may be applied by advancing a veneer sheet into the path of an ejection system in which liquid adhesive is ejected in a deluge over the surface of the sheet. The excess adhesive deposited upon the surface is subsequently removed so that a regulated film or coat of desired thickness remains evenly distributed on the surface of the veneer sheet.

By deluging the veneer, the entire face is covered with adhesive irrespective of the thickness of the veneer sheet. Further, it has been noted that because of the splattering of the adhesive as it is ejected on a veneer face, the adhesive tends to be moved about on the veneer so as to work into the fibers and grain structure of the veneer so that substantially the entire surface area is impregnated with adhesive. Excess adhesive removed from the surface of the sheet may then be treated so as to remove any impurities introduced into the adhesive, and then recirculated for further use. The system is extremely easy to adjust and maintain, and the requirement for any applicator roll is eliminated.

The apparatus is shown in Figures 1 and 2. A deluge of liquid adhesive is deposited on opposite faces of the veneer sheets by applicators 11 and 12, the conditions present causing the adhesive to saturate the entire surfaces of the veneer sheets. Excess adhesive is then removed by wiper members 13 and 14 so that a regulated coat or film of adhesive remains distributed on the veneer sheets.

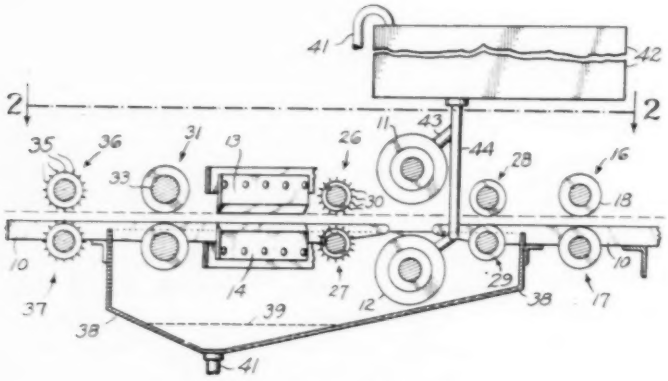

Figure 1

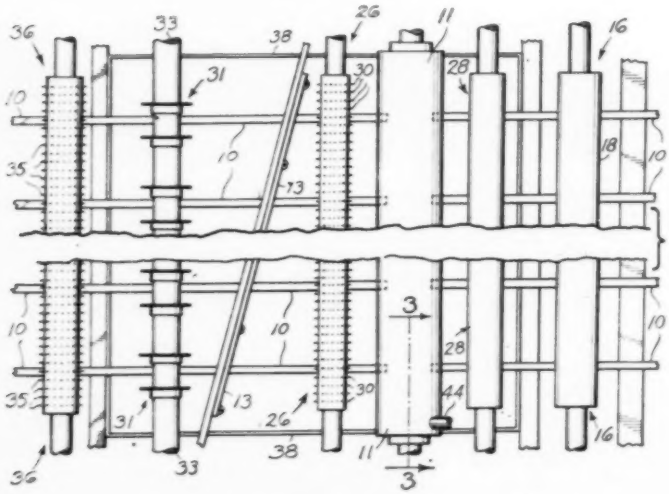

Figure 2

Treating Fibrous Material to Improve Adhesion to Rubber

U. S. Patent 2,902,398, issued Sept. 1, 1959 to Carl W. Schroeder and assigned to Shell Development Co., describes a method for treating fibrous textile material such as rayon and nylon tire cord to improve their adhesion to rubber. The invention is particularly adapted for use in preparing tubeless tires.

The process consists of treating the fibrous textile material with an aqueous medium containing a polyepoxide having an epoxy equivalency per 100 grams greater than 0.20, and an epoxy curing agent, drying the materials and then treating the dried material with a liquid medium containing rubber and a fusible condensate of an aldehyde and phenol.

Bonding Rubber to Metal

U. S. Patent 2,900,292, issued Aug. 18, 1959 to Elmer W. Coleman, Jr., and Donald M. Alstadt, assigned to Lord Manufacturing Co., provides a method of bonding rubber to metal. The adhesive composition used consists of an allylically brominated 2,3-dichlorobutadiene — 1,3 polymer and a metal adherent such as a thermosetting phenaldehyde resin.

Rapid-Set Aqueous Adhesive

U. S. Patent 2,902,458, issued Sept. 1, 1959 to Jan Teppema and assigned to the Borden Co., provides adhesives useful in the bonding of wood, fabric, paper, and similar products. The adhesive sets rapidly at room temperature and has an extremely high shear strength.

For example, a polyvinyl ester emulsion of this type may be prepared by mixing 50 parts by weight of water, 50 parts of vinyl acetate, 6 parts of polyvinyl alcohol (emulsifier), 3 parts of sodium acetate, and 0.1 part of potassium persulfate (catalyst). The ingredients are reacted in a vessel equipped with a reflux condenser and an agitator at 75°C. for two hours.

Glue Head for Box Folding Machine

U. S. Patent 2,902,000, issued Sept. 1, 1959 to Francis A. Connolly and assigned to S & S Corrugated Paper Machinery Co., Inc. provides a gluing device for spreading glue on the flaps of boxes, while at the same time protecting other flaps from being soiled.

Figure 3

As shown in Figures 3 and 4, each of the housing guards, 20,20', forms a glue chamber whereby the respective roller 24,24', is constantly immersed as to a portion of its surface in glue for spreading on a flap surface passing above the roller as shown in Figure 3 or below the roller

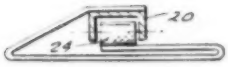

Figure 4

as shown in Figure 4. Regardless of which roller unit is in use, the guard housing protects the opposite flap of the carton from becoming glue contaminated. Thus, in Figure 3 the guard housing 20' is intermediate the dry flap and the roller, which in Figure 4 the guard housing 20 is intermediate the dry flap and roller.

Modified Animal Glue

U. S. Patent 2,900,267, issued Aug. 18, 1959 to Edward F. Cavanaugh and Havard L. Keil, assigned to Armour & Co., provides an esterified animal glue product which has a reduced gelling temperature, increased stability of viscosity, increased solubility in water, and appreciable solubility in polar organic solvents.

The invention is based on the discovery that animal glue can be chemically modified to produce a glue having the above characteristics by reacting an aqueous non-alkaline solution of animal glue with an alkylene oxide, such as styrene oxide.

Adhesive for Silicon Rubber and Glass

U. S. Patent 2,898,224, issued Aug. 4, 1959 to Keith E. Polmanteer and assigned to Dow Corning Corp., provides an adhesive composition suitable for adhering vulcanized silicone rubber to glass. The adhesive consists of ethylpolysilicate and from .1 to 5 per cent by weight of an aliphatic carboxylic acid salt of an alkyl tin compound.

Other Patents of Interest

Subject	Inventor or Assignee	Patent No.	Date
Folding and glueing apparatus	The International Paper Box Machine Co.	2,899,873	8/18/59
Sizing composition containing fatty acid	American Cyanamid Co.	2,901,371	8/25/59
Rubber-resin adhesive solution	Phillips Petroleum Co.	2,901,448	8/25/59
Apparatus for applying pressure sensitive materials	Wolf Brothers, Inc.	2,901,999	9/11/59
Bonding polysiloxanes to a surface	Dow Corning Corp.	2,902,389	9/11/59
Preventing distortion in pressure-sensitive adhesive tapes	Johnson & Johnson	2,903,379	9/18/59
Paper size	Corn Products Co.	2,903,391	9/18/59

Some Folks Say Glue is Glue

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digits of magnetic core storage with variable field length and immediate accessibility. It has paper tape and electric typewriter input and output. Programming is simplified by two advanced programming systems and a comprehensive library of mathematical and statistical routines. It is expected to be ready for delivery late this year on a rental or sales basis. *Data Processing Div., International Business Machines Corp.* **E-160**

Ball-Point Gum Dispenser

A pen-shaped adhesives dispensing device releases one dot of rubber cement whenever the ball point is depressed. The amount is sufficient for adhesion of paper to virtually any other surface. It leaves no permanent residue or stain and may be removed simply by rubbing. One filling of the pen suffices for approximately 5000 dots. Plastic refill bottles are good for another three fillings. Suggested uses include adhesion of papers that may be quickly separated afterwards without tearing, thereby avoiding bulky paper clips and staples in correspondence files. *Devon Tape Corp.* **E-161**

Speedy-Marx Markers

A complete line of Speedy-Marx pressure sensitive markers and signs are now available on quick-release Red Rocket cards. The new quick-dispensers permit markers to be peeled off easily and smoothly and to be applied without distortion. Red Rocket cards are coated with a specially compounded film which releases the waterproof markers instantly. The coating is said to completely protect the adhesive qualities of the signs and markers and assembled units have unlimited shelf life. Speedy-Marx waterproof vinyl markers include standard pipe, wire and electrical markers, accident-prevention signs, numerals and letters, and identification signs. It is claimed that all remain unaffected by grease, dirt, oil and abrasion; are always legible; and conform to NEMA-ASA specifications. *North Shore Nameplate Inc.* **E-162**

Pressure Detector

A resistance pressure detector is available to measure gas, fluid or vapor pressures in combination with a temperature monitoring unit. The detector converts pressure directly to an electrical resistance. A wide variety of ranges is available to provide constant observation from low pressures, measured in inches of mercury, to those of 5000 psi. Each alarm pressure can be changed easily by means of a screwdriver adjustment on the front of the monitor. *Thomas A. Edison Industries of McGraw-Edison Co.* **E-163**

Pop-Up Top Coater

An automatic roller coater designed for partial coating of stock in a specially predetermined location, the Pop-Up Top Coater combines electric eye, limie switch control and variable timer to apply the coating in exactly the spot desired. Adaptable to virtually any fluid coating job on any flat surface, the Pop-Up coater is furnished with roller lengths from 12 to 108 inches. In applying contact adhesives to plastic materials, the sheets are conveyor-fed into the machine through a set of nip rolls located on the infeed side. Individual stops on the nip rolls regulate the feed speed. The manufacturer states that since this is a reverse coating process, heavy viscous films can be applied. The variable timer allows the sheets to pass through the coater to a predetermined position, at which point a signal is sent to an overhead air cylinder holding up the coating roll assembly. The coating roll then lowers and applies the adhesive to the sheets. A second variable timer lifts the coating roll when the desired amount of adhesive has been applied. Timers can be set for various lengths or set to give skip coatings of various patterns to the product. *Union Tool Corp.* **E-164**

Plastic Comparator

A reinforced plastic comparator in the form of a large slide rule allows design engineers to compare rapidly the specific properties of 12 proprietory laminate materials. On the reverse side are charts and tables compiled from military sources and

manufacturers' literature, bringing together basic design criteria for initial evaluation of various laminate systems. Condensing several thousand data units for quick reference, this materials evaluator promises a considerable saving in time and research to design and process engineers, fabricators, planners, purchasing agents and salesmen. An estimated 2½-foot stack of technical information on Fiberglas has been included. *Visualized Technical Services, Inc.* **E-165**

FOR MORE INFORMATION on the new equipment items described here, use the Reader's Service Card elsewhere in this issue.

Temperature Regulator

An air controlled temperature regulating system has been developed by the manufacturer which provides extremely accurate temperature control for systems subjected to wide and sudden load swings. The manufacturer reports that control accuracy of 6° to 8°F. over a 24-hour period under severe test conditions has been demonstrated. Instantaneous load swings from 210 gpm down to 80 gpm water flow were easily handled while controlling temperature to within plus or minus 5° of the set point. The immediate response to sudden changes in demand is made possible by the pressure regulating action of an externally piloted main valve. Precise temperature control is obtained from a cascaded air system which loads the pilot. By combining both functions in one system, the manufacturer has eliminated the need for a pressure reducing valve so often required ahead of the diaphragm-motor valve in instrument control systems. Quick response of the temperature system is based on a bimetal temperature sensing element. Almost any range of temperature setting is available. Heater pressures up to 90 psi can be obtained with 15 psi air loading pressures. Valves are available for this system in sizes ranging from ¼ inch up to 12 inches. *Spence Engineering Co., Inc.* **E-166**

Laminate Trimmer

Unusual power and precision features characterize a new laminate trimmer that automatically produces a standard 22-degree bevel. The design permits utilization of ample power for heavy-duty production work. In operation, the new trimmer

can be set for high-precision work with virtually fool-proof adjustment controls, a distinct asset in working on high-priced laminates. Either alternating or direct current operation is possible, at 25, 40, 50 or 60 cycles, and voltages of 115, 220 and, on special orders, 125 or 240. Held like a jackknife, the trimmer can be operated from left to right or vice versa, for the benefit of left-handed persons. The trimmer is capable of replacing two generally used laminate tools—a rough cutter and a bevel cutter. *Black & Decker Manufacturing Co.* **E-167**

Glue-Forming Machine

The machine forms trays and cartons with adhesives at reported speeds up to 70 per minute, depending upon carton size and board characteristics. The unit has such features as full protection against moisture-loss, against contamination from paper dust, against oxidation; one loading of the stainless steel glue reservoir is ample for 8 hours of production; a dial control which meters the precise amount of glue to be extruded to the glue flaps; and if no blank is fed, no glue is fed. By turning a regulator valve, from 4,000 to 8,000 pounds of compression may be selected. The machine offers a quick and accurate means of changing from one carton size and style to another, with the use of precision size change parts which fit into pre-set, dowelled positions. The unit, called Head-Seal, is 57½ inches long, 49 inches wide, and 68 inches high with hood guard closed. An additional 23 inches in height can be obtained with hood guard in raised position. The unit, including the forming head, weighs 1750 pounds. *Head-Seal Packaging Corp.* **E-168**

Collapsible Box

The Kennett collapsible box is designed to provide a large-capacity container, easily handled by fork lift, which can be collapsed into only 6 inches of its original height for returning to storage. The collapsing is done by means of sturdy piano type hinges which connect the box's solid side panels, split end panels and base. Since all collapsing components are firmly hinged together, no parts can become separated and lost. A specially-designed stacking foot permits fork lifts to handle the boxes, singly or stacked, from all four sides. Side and end panels and the bottom of the box are made from Vulcaneer fiber-armored plywood, and the edges of the box and lid are reinforced with metal holdings. Four standard sizes are available, as well as special sizes up to a maximum length of 60 inches and a maximum weight for standard construction of 300 pounds for a single box or 1000 pounds in any one stack of boxes. *National Vulcanized Fiber Co.* **E-169**

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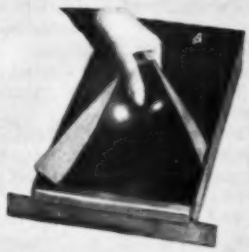

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book reviews

Operations Research for Industrial Management. ***By Dimitris N. Chorafas. Published by Reinhold Publishing Corp., 430 Park Avenue, New York 22, N.Y. 6 x 9 in. 303 pp. $8.75.***

Systems analysis and operations research proved their value in solving complex military problems during World War II. The postwar period has seen the adaptation of these methods to the workings of the billion dollar corporation and large-scale government. More and more the intuition of the industrial executive has been supplanted by the analysis of giant electronic computers based on "mathematical models." This book, written by a man with a distinguished academic and industrial background, furnishes an excellent introduction to the theory of operations research illustrated by a wealth of simulated case material.

One does not have to be a mathematician to understand the import of the theories discussed, but a good grounding in applied mathematics is a prerequisite. With very simple examples the reader is led into the fundamentals of simulation and prototype models involving million-dollar production decisions. The book includes the application of operations research methods to a variety of business problems in which optimization under conditions of one or more unknowns is the objective: financial allocation, transportation problems, inventory control and production setups.

Entertainingly written, this book is intended primarily to assist department heads and others in the middle levels of management allocate finite resources more rationally to arrive at long-term evaluations and selections. It constitutes a concise presentation of game theory, linear programming, simulation theory, flow techniques and matrix algebra. A lucid account of strategic gaming represents some of the most advanced thinking in the field today.

Chemistry of Plant Gums and Mucilages and Some Related Polysaccharides. ***By F. Smith and R. Montgomery. Published by Reinhold Publishing Corp., 430 Park Avenue, New York 22, N.Y. 6 x 9½ in. 627 pp. $18.00.***

Plant gums and mucilages have been known since Biblical times and are still in use either as they are found in nature or as aqueous extracts of parts of plants. However, the utilization of these polysaccharide polymers may very well increase substantially when their chemistry is better understood. In the present volume, an attempt has been made to bring together all that is now known of the chemistry of these materials and to indicate some new avenues of research.

The book, Number 141 in the series of monographs offered by the American Chemical Society, contains 17 chapters which cover material ranging from the function and origin of natural gums to a discussion of synthetic gums and gum derivatives. An account is given of the industrial applications in fields such as adhesives, textiles, cosmetics, pharmacy and paints. A valuable appendix details the types of plant gums and mucilages used in the various industrial fields and refers the reader to specific sections in the book.

In view of the increasing commercial importance of these materials, this book is a valuable contribution to our understanding of their still unexplored potential.

Amino Resins. ***By John F. Blais. Published by Reinhold Publishing Corp., 430 Park Avenue, New York 22, N.Y. 5 x 7½ in. 220 pp. $4.95.***

In 1957, Reinhold began its Plastics Applications Series with 16 titles in prospect. The current volume on amino resins is only the thirteenth to appear, but the company has announced that the advent of new plastics materials has induced it to lengthen the handy series with eight additional titles.

The purpose of John Blais' book is to detail the various applications for amino resin products, and identify the different types of this material used in specific applications. For the most part, only commercially available resin materials are discussed, and the author focuses particular attention on practical applications. Described in detail are applications in adhesives, molding, laminating, textiles, surface coatings and paper. In his chapter on adhesives, Mr. Blais points out that amino resins are used in bonding plywood, furniture and bag seams. A particularly full treatment is given to the use of these resins as binders in particle board.

FOR MORE INFORMATION on the trade literature reviewed here, use the Reader's Service Card elsewhere in this issue.

Trade Literature

General Purpose Control Catalog. Information on the complete line of control devices manufactured by GE's General Purpose Control Department is contained in this 72-page catalog. This includes descriptions of both manual and magnetic motor starters, contractors, relays, solenoids, limit switches, push buttons, static control and pilot devices. Pricing tables for each device are included with descriptive information. Features, wiring diagrams, dimensions and application information for each device are given. *General Electric Co.* L-174

Adhesives for Brewers. The information in this eight-page publication is specifically directed at those concerned with buying, specifying or the actual use of adhesives in a brewery. Data is given on ice-proof bottle labeling adhesives, six pack adhesives, case sealing adhesives and an assortment of adhesives for special purposes. Detailed advice is given on the proper mixing and storing of adhesives. Factors to be considered in choosing a bondant for any specific operation are discussed. *H. B. Fuller Co.* L-175

Thermogrip. The use of hot melt adhesive in coil form is detailed in this 15-page booklet. Information is also given on various types if applicators and the features of each which recommend it for particular industrial production lines. In addition, the pictures and text outline the services of the company's testing laboratory. The latter is available for evaluating the adherability of any combination of materials or objects. *United Shoe Machinery Corp.* L-176

New Vistas for Vinyl-Metal Laminates. Pictures and text of this five-page pamphlet describe the various manufacturing steps in the production of vinyl-metal laminates. The material covered includes: preparation of the backing, applying the vinyl, curing and trimming. It points out how recent improvement in these laminates now make welded assemblies practical. *Arvin Industries, Inc.* L-177

Nopco Chemicals for Latex Compounding. Listed in this five-page booklet are chemicals used in latex compounding to produce changes in stability, viscosity and penetration as well as in adhesion, pigment dispersion and foam control. The materials described are all products of the company's Protective Coatings Department. *Nopco Chemical Co* L-178

TECHNOLOGY OF ADHESIVES AT YOUR FINGERTIPS

A A SERVICE

Subscribers to ADHESIVES AGE may now obtain, from one central source, technical literature dealing with all aspects of the adhesives industry. One or more of the books listed here may be of invaluable assistance to you. Look this list over and check the books suited to your needs.

- **Adhesive Bonding of Metals—G. Epstein. $2.95.** Considers adhesives used with metals, indicating when an adhesive-bonded joint is advantageous; the type adhesive to use; how to use it, and how to design the joint for optimum performance. ☐

- **Adhesive Bonding for Fibrous Glass Reinforced Plastics—H. A. Perry. $8.75.** A theoretical and practical manual on the joining of glass reinforced plastics. ☐

- **Adhesion and Adhesives—N. A. De Bruyne and R. Houwink. $13.50.** A collection of information on the scientific and technological aspects of adhesion. Part I deals with theory, while Part II is devoted to the technology of adhesion. ☐

- **Epoxy Resins—Their Applications and Technology—H. Lee and K. Neville. $8.00.** Guide to the field of epoxy resins, covering the chemistry of their preparation and applications, including a section on adhesives. ☐

- **Polyamide Resins—Donald E. Floyd. $4.50.** Discusses in detail various important applications of the polymers belonging to the polyamide resin family and includes a comprehensive section on adhesives. ☐

- **Principles of High Polymer Theory and Practice—A. X. Schmidt and C. A. Marlies. $13.50.** Study of the principles of high-polymer theory and practice, with a section on adhesives, their applications, and mechanisms and factors involved. ☐

- **Recent Advances in Gelatine and Glue Research—G. Stainsby (Editor). $12.00.** Study of Collagen, and its protein gelatine, comprising papers and Proceedings of an International Conference of the British Gelatine and Glue Research Association. ☐

- **Rubber-to-Metal Bonding—S. Buchan. $4.00.** Discusses methods for bonding natural and synthetic rubbers to metals of all kinds, for use by those who manufacture rubber-metal units, and of interest to the rubber-minded engineer. ☐

- **Vinyl Resins—Mayo Smith. $5.75.** Surveys applications of vinyl resins with information on their types, properties, chemistry, manufacture and fabrication. Includes information on several types of adhesives in this category. ☐

- **Epoxy Resins—Irving Skeist. $5.50.** A chapter on adhesives is included in this complete study of the entire field of epoxy resins. The author gives formulations, trade names, methods of manufacture and applications. ☐

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DMF Bulletin. This bulletin summarizes the latest laboratory data on the use of dimethylformamide (DMF) as a polyvinylchloride resin solvent. The information will be of particular interest to companies manufacturing protective coating formulations. According to the bulletin, DMF's powerful solvent effect allows use of high resin content solutions giving thicker coatings in roller or spray applications. Its medium range boiling point suggests use in baked-on coatings. *E. I. du Pont de Nemours & Co.* L-179

Adhesives for Bonding Polystyrene. Three adhesives which have been tested for use in bonding polystyrene materials are covered in this 18-page booklet entitled "Adhesives for Bonding Polystyrene to Various Materials of Construction." The adhesives discussed are designated A-827-B, R-1083-T and 800-X-8002. The booklet gives a description of each adhesive as well as its properties, uses and application procedure. *B. F. Goodrich Industrial Products Co.* L-180

Morningstar-Paisley Has Already Touched Your Life Several Times Today. This eight-page illustrated booklet lists the industries and manufactured goods in which the company's products are used. The origin of the raw materials is given as well as detailed descriptions of the adhesives, processed starches, gums, etc. Some of the industrial applications covered are in the fields of bookbinding, paper converting, packaging, textiles, wood products, toy manufacturing and food processing. *Morningstar-Paisley, Inc.* L-181

Plastic and Chemical Materials. This 12-page, illustrated brochure presents physical properties of a complete line of polycarbonate resins, phenolic resins, varnishes and molding powders, and fused magnesium oxide. It has been compiled as an aid to designers, fabricators, formulators and end-users, in the specification of polycarbonate, phenolic and magnesium oxide materials. A considerable amount of data has been compressed into graphs and tables. This technical treatment should prove particularly helpful to molders, laminators, foundry operators and protective coating manufacturers. *Chemical Materials Dept., General Electric Co.* L-182

Protective Coatings. This profusely illustrated 11-page pamphlet gives complete information on various types of protective coatings and the specific applications in which they may be used. Included are reprints of articles which originally appeared in leading industrial magazines. The features of each type of coating are described and information given on necessary surface preparation and application techniques. *David E. Long Corp.* L-183

The Characteristics of Pressure Sensitive Adhesives. Reprinted in this five-page publication is a talk delivered by Frank H. Wetzel, research chemist of the Hercules Powder Co., Wilmington, Del., at the 59th Annual Meeting of ASTM. It covers quantitative methods for a study of factors affecting pressure-sensitive adhesion and points out that these methods can be utilized in studying the effects of plasticizers, fillers and stabilizers. *Instron Engineering Corp.* L-184

Epoxy Resin Adhesive Pack. A two-page brochure details the new design features of an adhesive pack in which epoxy resin and curing agent are kept in separate plastic containers until ready for use. Advantages of the hermetically closed system are outlined in terms of economy, ease of application, long storage life and safety. A three-part pack, containing resin, agent and patching material, is also described. *Fenwal Inc.* L-185

Fibrous-Glass Boats. Prevention of fire loss and damage through the incorporation of polyester resin in fibrous-glass boats is the theme of an illustrated, four-page folder. The text, in question and answer form, discusses the properties of an inherently flame-resistant polyester and its use in U.S. Navy ships, industrial work boats and pleasure craft. *Durez Plastics Div., Hooker Chemical Corp.* L-186

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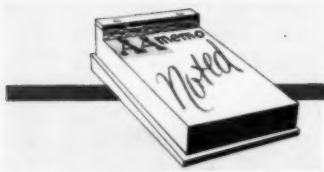
ADVERTISERS' INDEX

ADHESIVE AGE
FEBRUARY 1960

Adhaesion	64
American Latex Products Corp.	3
Colton Chemical Co. Division of Air Reduction Co., Inc.	13
Darling & Co., Glue Div.	5
Day, J. H., Co.	55
duPont de Nemours, E. I. & Co., Inc.	17
Dural Co., Inc.	8
Fox, John P., Co., Inc.	9
Franklin Glue Co., Inc.	65
Hysol, Inc.	Cover 4
Nopco Chemical Co.	4
Pennsylvania Industrial Chemical Corp.	11
Permacel	21
Philadelphia Quartz Co.	53
Potdevin Machine Co.	61
Roberts Co.	Cover 2
Ross, Charles & Son, Inc.	15
Rubber & Asbestos Corp.	6
Rubber-to-Metal Bonding	19
Rubber Red Book	57
Schenectady Varnish Co., Inc.	47
Semco Sales & Service, Inc.	53
Shawinigan Resins Corp.	Cover 3
Stauffer Chemical Co.	59
Tamms Industries Co.	8
van Ameringen-Haebler, Division of International Flavors & Fragrances, Inc.	15



in passing

Smaller Paychecks

Uncle Sam's tax scissors will cut a slightly larger corner from your paycheck in 1960 as your contribution to the Social Security program. Effective January 1, the Social Security tax went up to 3 per cent both for you and your company. This tax will be paid on the first $4,800 of your annual earnings. How much extra is deducted depends, of course, upon how much you make. If you make $4,800 or more, you will pay $144 in 1960 as against the $120 you paid in 1959. The Social Security insurance program provides protection for most Americans against the hazards of retirement, disability, and death. Today, over 13 million beneficiaries are receiving over $800 million each month in Social Security benefits. Congress enacted the increased Social Security taxes to assure the continuing self-supporting nature of the Old-Age and Survivors Trust Fund and the Disability Trust Fund.

More for Postage

Mailing costs are going up again. The Post Office Department recently won authority to boost parcel post rates by an average of 17.1 per cent. The increases, depending on distance shipped and size of packages, range from 1 to 35 per cent. The higher rates will cost mail users some $88 million a year. Postal officials plan to put the new rates into effect on February 1. However, the rates have been appealed by a group of mail users and this could delay the effective date, or possibly reverse the action. Meanwhile, the Administration is set to ask for another boost in first class mail rates. Congress recently turned down a request for another 1¢ hike in first class rates. A 2¢ boost may be asked in 1960.

Frustration Survey

Did you ever get all ready to start a project and couldn't find an indispensable tool or piece of paper? You're not alone, says the publication *Vision*. A "frustration survey" would show that everybody: puts time and effort into work that turns out to be useless; finds his efforts undone by somebody else; gets further delayed when he is already late; loses out on something that was already in the bag; finds an apparently simple task difficult to do; often fails to get what he wants; has his best-laid plans fall apart; now and then finds everything just too much for him.

Who Would Have Thought It?

Those cattails the lady-folks treasure for dried flower arrangements may one day spark a bonanza that will make the 140,000 square miles of cattail swampland in the U.S. as valuable as the wheat fields of the midwest, so reports *The Laboratory*, a publication of the Fisher Scientific Co. From Syracuse University's Cattail Research Center, scientists are reporting uses for everything from the buried stems (or rhizomes) to the "tail" itself. The rhizomes can be eaten like potatoes or made into flour for baking. The stems above ground, already used for caulking barrels, yield valuable fibers, as do the leaves. The tail is recommended for use as stuffing in life preservers and cushions; as insulation board material; as a poultry and cattle feed; and as a source for cooking oil, wax and coating materials for paper.

The Yankee Dollar

A U.P.I financial writer, Robert G. Shortal, is trying to correlate the New York Yankee's winning World Series performances with economic prosperity throughout the country. After the Yankees won the World Series in 1958, he noted that several other championship years—1927, 28, and 47—were good ones economically, then pointed out that 1929 and 1948, both losing years for the Yankees, were also losing years for the economy. To give the theory even more zest, he adds, there is an exception to the rule: the Yankees won in 1932. *Fortune* magazine then poses this puzzler: Do the Yankees win because times are good, or are times good because the Yankees win?

Management Training

Industrial companies report that they will spend more on formal management training programs in the future than they have so far. Preference is indicated for on-the-job training for future executives; also for courses in personnel management, money management and over-all management.

Informative Advertising

A Gallup survey for *Redbook* magazine says that for profitable advertising, remember that customers want all the information they can get. The higher the customer's position on the socio-economic scale, the more he depends on advertising for information.